PHILIPS

Data handbook

PHILIPS Electronic components and materials

Components and materials

Part 12 June 1982

Variable resistors

Test switches

COMPONENTS AND MATERIALS

PART 12 - JUNE 1982

VARIABLE RESISTORS AND TEST SWITCHES

DATA HANDBOOK SYSTEM

Our Data Handbook System is a comprehensive source of information on electronic components, sub-assemblies and materials; it is made up of four series of handbooks each comprising several parts.

ELECTRON TUBES	BLUE
SEMICONDUCTORS	RED
INTEGRATED CIRCUITS	PURPLE
COMPONENTS AND MATERIALS	GREEN

The several parts contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where ratings or specifications differ from those published in the preceding edition they are pointed out by arrows. Where application information is given it is advisory and does not form part of the product specification.

If you need confirmation that the published data about any of our products are the latest available, please contact our representative. He is at your service and will be glad to answer your inquiries.

May 1980

ELECTRON TUBES (BLUE SERIES)

The blue series of data handbooks is comprised of the following parts:

T1 **Tubes for r.f. heating**

T2 **Transmitting tubes for communications**

T3 **Klystrons, travelling-wave tubes, microwave diodes**

ET3 **Special Quality tubes, miscellaneous devices** (will not be reprinted)

T4 **Magnetrons**

T5 **Cathode-ray tubes**
Instrument tubes, monitor and display tubes, C.R. tubes for special applications

T6 **Geiger-Müller tubes**

T7 **Gas-filled tubes**
Segment indicator tubes, indicator tubes, dry reed contact units, thyratrons, industrial rectifying tubes, ignitrons, high-voltage rectifying tubes, associated accessories

T8 **Picture tubes and components**
Colour TV picture tubes, black and white TV picture tubes, colour monitor tubes for data graphic display, monochrome monitor tubes for data graphic display, components for colour television, components for black and white television and monochrome data graphic display

T9 **Photo and electron multipliers**
Photomultiplier tubes, phototubes, single channel electron multipliers, channel electron multiplier plates

T10 **Camera tubes and accessories, image intensifiers**

T11* **Microwave components and assemblies**

* Will become available in the course of 1982.

SEMICONDUCTORS (RED SERIES)

The red series of data handbooks is comprised of the following parts:

S1 **Diodes**
Small-signal germanium diodes, small-signal silicon diodes, voltage regulator diodes(< 1,5 W), voltage reference diodes, tuner diodes, rectifier diodes

S2 **Power diodes, thyristors, triacs**
Rectifier diodes, voltage regulator diodes (> 1,5 W), rectifier stacks, thyristors, triacs

S3 **Small-signal transistors**

S4 **Low-frequency power transistors and hybrid IC modules**

S5 **Field-effect transistors**

S6 **R.F. power transistors and modules**

S7 **Microminiature semiconductors for hybrid circuits**

S8 **Devices for optoelectronics**
Photosensitive diodes and transistors, light-emitting diodes, displays, photocouplers, infrared sensitive devices, photoconductive devices.

S9 Taken into handbook T11 of the blue series

S10 **Wideband transistors and wideband hybrid IC modules**

INTEGRATED CIRCUITS (PURPLE SERIES)

The purple series of data handbooks is comprised of the following parts:

IC1 **Bipolar ICs for radio and audio equipment**

IC2 **Bipolar ICs for video equipment**

IC3* **Digital ICs for radio, audio and video equipment**

IC4 **Digital integrated circuits**
LOCMOS HE4000B family

IC5 **Digital integrated circuits – ECL**
ECL10 000 (GX family), ECL100 000 (HX family), dedicated designs

IC6* **Professional analogue integrated circuits**

IC7 **Signetics bipolar memories**

IC8 **Signetics analogue circuits**

IC9* **Signetics TTL circuits**

* These handbooks will be available in the course of 1982.

COMPONENTS AND MATERIALS (GREEN SERIES)

The green series of data handbooks is comprised of the following parts:

C1 **Assemblies for industrial use**
PLC modules, PC20 modules, HNIL FZ/30 series, NORbits 60-, 61-, 90-series, input devices, hybrid ICs, peripheral devices

C2 **FM tuners, television tuners, video modulators, surface acoustic wave filters**

C3 **Loudspeakers**

C4 **Ferroxcube potcores, square cores and cross cores**

C5 **Ferroxcube for power, audio/video and accelerators**

C6 **Electric motors and accessories**
Permanent magnet synchronous motors, stepping motors, direct current motors

CM7a **Assemblies** (will not be reprinted)
Circuit blocks 40-series and CSA70(L), counter modules 50-series, input/output devices

C8 **Variable mains transformers**

C9 **Piezoelectric quartz devices**
Quartz crystal units, temperature compensated crystal oscillators, compact integrated oscillators, quartz crystal cuts for temperature measurements

C10 **Connectors**

C11 **Non-linear resistors**
Voltage dependent resistors (VDR), light dependent resistors (LDR), negative temperature coefficient thermistors (NTC), positive temperature coefficient thermistors (PTC)

C12 **Variable resistors and test switches**

C13 **Fixed resistors**

C14 **Electrolytic and solid capacitors**

C15 **Film capacitors, ceramic capacitors, variable capacitors**

C16 **Piezoelectric ceramics, permanent magnet materials**

January 1982

For easy reference, type numbers (such as CP13) are at the top of each page. Orders should, however, always state the 12-figure catalogue number.

This Handbook is in four sections as shown in the survey below. The Index of catalogue numbers with page number references is at the end of the book.

All dimensions on drawings are in mm unless otherwise indicated. According to the S.I. units the symbol K (kelvin) is used instead of °C in combinations such as K/W. Also ΔT is in K. Atmospheric pressure is given in kPa instead of millibars, mm Hg etc.
1000 mbar = 100 kPa.

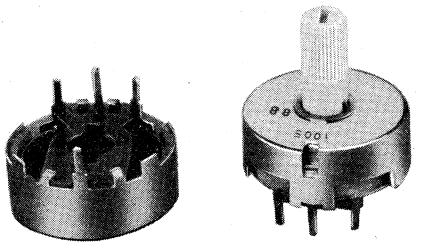
SURVEY

	wirewound	carbon	cermet	
preset	TWP22	CMP10 CMP20 CMP40 CTP10 CTP14 CTP18 ECP10	EMP10 MTP10 MFU4,5 MFU7	MPG256 Test switches Band switches
control	LP36 LP46 LP66 WP22 WP23 WP24 WP42	CP13 CP16 CP23 CSP25 CSP40 CSP60 PP17 PP17M PP17MT		

Some devices are labelled **"MAINTENANCE TYPE"**

Maintenance type - Available for equipment maintenance.
No longer recommended for equipment production.

WIREWOUND PRESET POTENTIOMETERS



RZ26449–3

QUICK REFERENCE DATA

Linear resistance law	
Resistance range	2,2 to 4700 Ω
Maximum permissible dissipation	
at 40 °C	2 W
at 70 °C	1,5 W

APPLICATION

In a wide variety of electronic equipment, e.g. for presetting of the horizontal and vertical convergence in colour television receivers.

CONSTRUCTION

The potentiometers consist of a single layer of a wire resistance element in a metal case. The resistance element and its terminal pins (a and c, see Figs 1 and 2) are insulated from the case; the slider is connected to the case (pin b).

Four types of potentiometer are available; with or without a centre tap (pin d) and with or without a plastic knob. The potentiometers are suitable for mounting on printed-wiring boards.

Note

The potentiometers are delivered with the slider at 50 ± 5% of the angle of rotation.

Outlines

Dimensions in mm

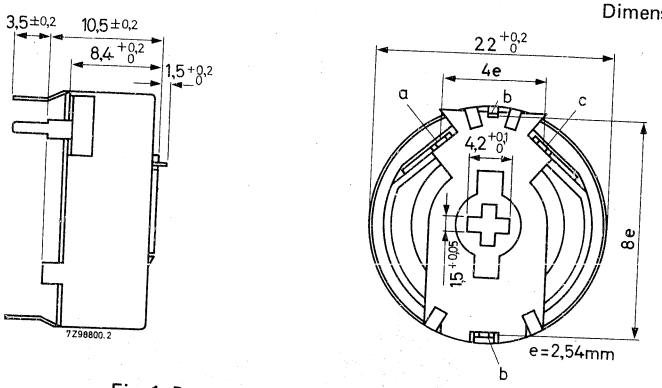


Fig. 1 Potentiometer without tap, without knob.

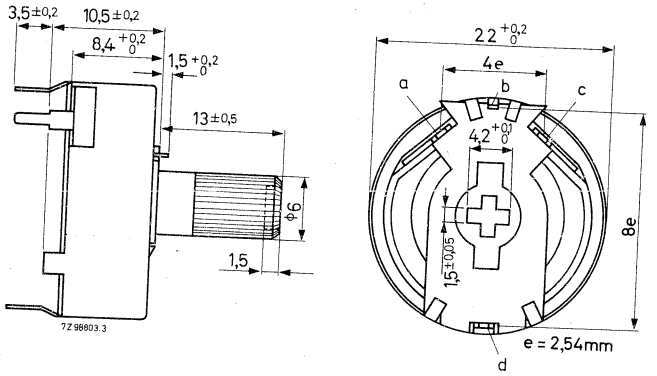


Fig. 2 Potentiometer with tap, with knob.

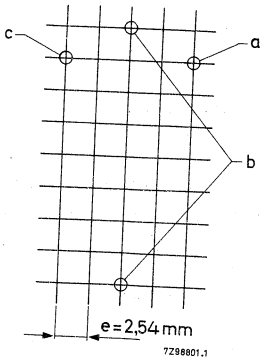


Fig.3 Mounting holes for potentiometers without tap.

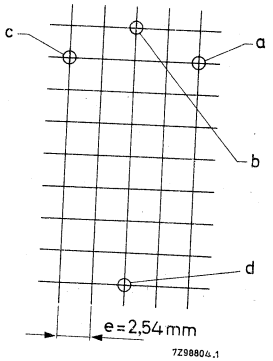


Fig.4 Mounting holes for potentiometers with tap.

TECHNICAL DATA

Nominal resistance (R_n) between a and c	2,2 to 4700 Ω see Table 1
Resistance law	linear, see Figs 5 and 6
Tolerance on R_n	±10%
Resistance at beginning and end of slider travel	⩽ 5% of R_{total}
Resistance at 50% of effective angle of rotation	50 ± 2% of R_{total}
Contact resistance between resistance element and slider	⩽ 500 mΩ
Change of contact resistance between resistance element and slider	⩽ 300 mΩ
Temperature coefficient	see Table 1
Maximum dissipation between a and c, potentiometer mounted on printed-wiring board (Fig.7)	
at T_{amb} = 40 °C	2 W
at T_{amb} = 70 °C	1,5 W
Ambient temperature range	−40 to +100 °C
Mechanical angle of rotation	255 ± 10°
Effective angle of rotation	240 ± 10°
Operating torque	10 to 40 mNm
Maximum end stop torque	150 mNm
Life	250 cycles

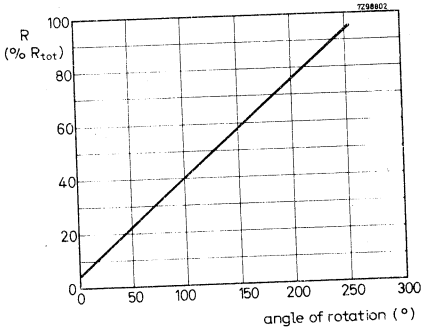


Fig.5 Resistance variation with the angle of rotation for potentiometers without tap.

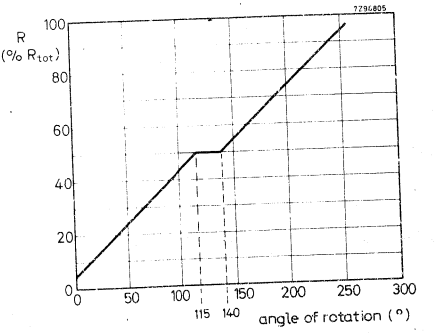


Fig.6 Resistance variation with the angle of rotation for potentiometers with tap.

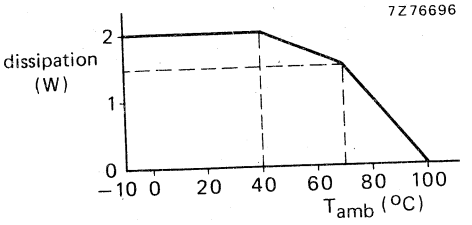


Fig.7 Dissipation as a function of the ambient temperature; potentiometer mounted on a printed-wiring board.

Table 1

resistance value Ω	temperature coefficient 10^{-6}/K	number of turns	code in catalogue number
2,2	0 to +600	110	228
3,3		108	338
4,7		95	478
6,8		136	688
10		126	109
15		194	159
22	−25 to +25	113	229
33		134	339
47		120	479
68		172	689
100		160	101
120	0 to +140	138	121
150		178	151
180		207	181
220		165	221
330		155	331
470		222	471
680		200	681
1000		297	102
4700		330	472
11 + 11	−25 to +25	113	229
50 + 50		160	101
150 + 150	0 to +140	150	301

COMPOSITION OF THE CATALOGUE NUMBER

2322 011 . . . . .

- without tap or knob * = 02
- with tap, without knob = 03
- without tap, with knob = 22
- with tap and knob = 23

→ resistance code, see Table 1

SPECIAL TYPE FOR 30AX TV DEFLECTION UNIT: 2311 011 90015

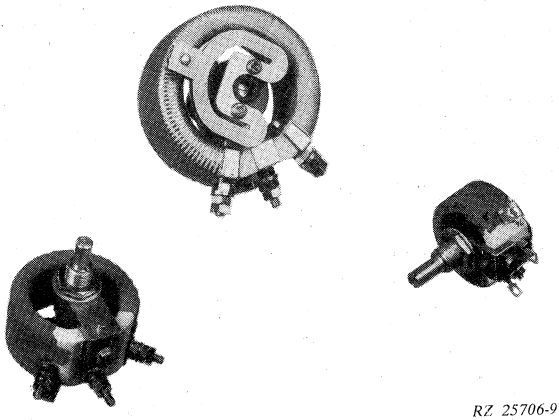
This type is identical to 2322 011 02181 except that $R_{min} = 34\ \Omega \pm 15\%$ and that the mechanical and electrical angle of rotation is smaller.

MARKING

The potentiometers are marked at the front with nominal resistance value (according to IEC62), production code (period and year) and code of manufacture (source code). Type 2322 011 90015 is marked: 011 90015, 180 Ω ± 10%, production code.

* Knobs are available under catalogue number 4322 048 20550.

LOAD POTENTIOMETERS



RZ 25706-9

QUICK REFERENCE DATA

Resistance range	0,5 Ω to 10 kΩ
Maximum permissible dissipation at 60 °C	25, 40, 100 W

APPLICATION

In electric and electronic equipment where current or voltage must be regulated continuously, e.g. control of motor speeds and control of charging current of batteries.

CONSTRUCTION

The potentiometers consist of a ceramic ring A (see diagrams on following pages) around which a resistance wire or ribbon (consult Table 1) has been wound in a single layer, over about 280° in the case of 100 W types, and over about 250° for the other types. Terminals B are fitted at each end of the wire or ribbon. With the exception of the top side of the coil, where the slider makes contact, the resistance element is coated with a protective layer of cement which prevents the windings from shifting. The cement is non-inflammable (melting point about 2000 °C).

A carbon brush C is affixed in a double spring-type runner E, the brush being connected to a terminal F via a double sliding-contact. The spring-pressures of the sliding contact and of the carbon brush are independent of each other. In the case of resistance ribbon, the runner of the 40 W and 100 W potentiometers has an extra spring having a height of 2 and 3 mm, respectively.

The runner is affixed to the top of a spindle J which is supported in a sturdy bracket K by means of an insulating piece G and a central screw H. A stop prevents the runner from overrunning the track, whereby the runner is not exposed to torsion.

The protrusion N prevents the potentiometers from rotating in the fixing hole. All the metal parts are non-corrosive. The potentiometers can be ganged (see "Ganging").

Outlines

Dimensions in mm

The spindle length L is 17 or 36 mm.

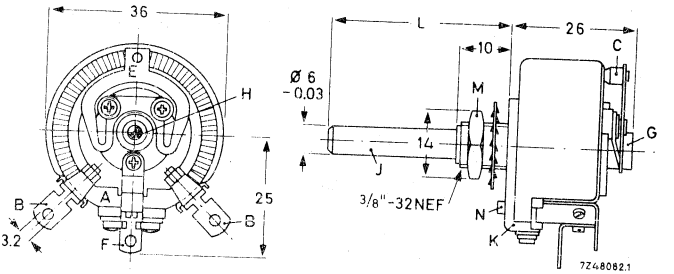


Fig. 1 Potentiometers 2322 095 .....; 1 Ω to 7,5 kΩ, 25 W.

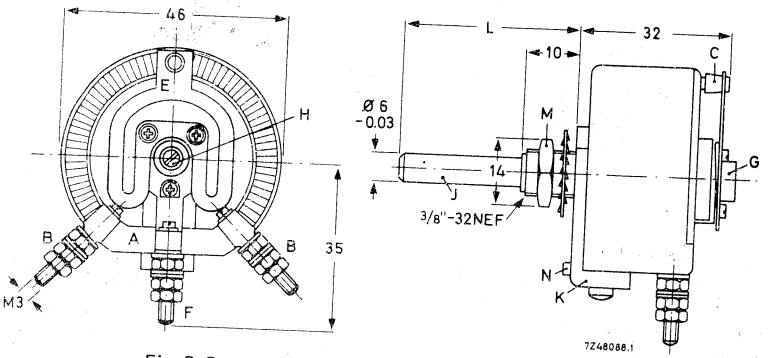


Fig. 2 Potentiometers 2322 096 .....; 0,5 Ω to 10 kΩ, 40 W.

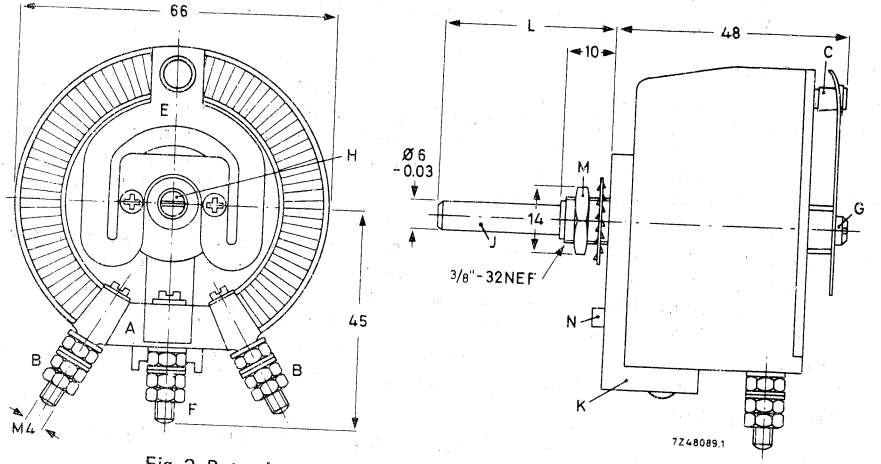


Fig. 3 Potentiometers 2322 097 .....; 0,75 Ω to 10 kΩ, 100 W.

Mounting

The potentiometers can be mounted on a panel with a maximum thickness of 5 mm or secured with a hexagonal nut which is supplied with each potentiometer (catalogue number of nut 4322 047 00380). See Fig. 4 for the required mounting holes in the panel.

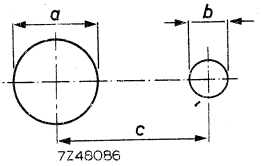


Fig. 4 Mounting holes

type	a mm	b mm	c mm
2322 095	10,5	3,5	13,5
096	10,5	4,8	20
097	10,5	4,8	20

Mass

type 2322 095	60 g
2322 096	95 g
2322 097	240 g

TECHNICAL DATA

Nominal resistance (R_n) measured between terminals	see Table 1
at $P \leqslant 0{,}1\ P_n$	± 10%
Tolerance on R_n	linear
Resistance law	(−140 to +140) 10^{-6}/K
Temperature coefficient of the resistance	
Maximum permissible dissipation at T_{amb} = 60 °C (P_n)	see Table 1
Maximum permissible current at T_{amb} = 60 °C ($I_{max} = \sqrt{\frac{P_n}{R}}$)	see Table 1
at other temperatures	see Fig. 5
Temperature rise ΔT as f(P)	see Fig. 6
Working temperature range	−55 to + 100 °C
Insulation resistance	> 100 MΩ
Effective angle of rotation	
25 W, 40 W types	250 ± 10°
100 W type	280 ± 10°
Mechanical angle of rotation	
25 W, 40 W types	270 ± 5°
100 W type	300 ± 5°
Operating torque	
25 W, 40 W types	10 to 45 mNm
100 W type	80 to 130 mNm
End stop torque	⩽ 2 Nm
Maximum axial spindle load	1 Nm
Life at maximum current	> 50 000 cycles

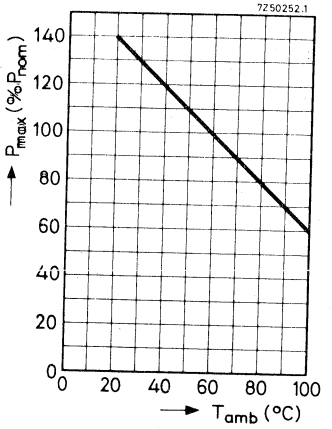

7Z50252.1
P_{max} (% P_{nom})
140
120
100
80
60
40
20
0
0
20
40
60
80
100
T_{amb} (°C)

Fig. 5.

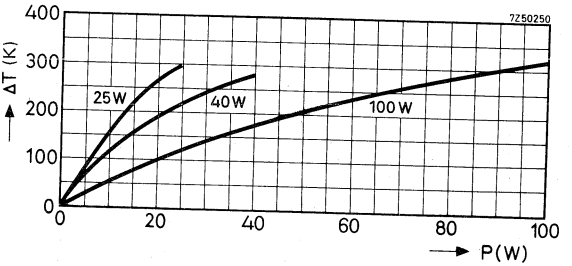

7Z50250
ΔT (K)
400
300
200
100
0
25W
40W
100W
0
20
40
60
80
100
P(W)

Fig. 6.

TYPES

Only the types for which I_{max} is listed in the table are available. If I_{max} is stated above the dashed line, the potentiometer is equipped with resistance ribbon.

Table 1

R_n Ω	P_n = 25 W		P_n = 40 W		P_n = 100 W		code in catalogue number
	I_{max} A	number of windings	I_{max} A	number of windings	I_{max} A	number of windings	
0,5			8,9	14			507
0,75			7,3	13	11,5	23	757
1	5,0	23	6,3	14	10,0	24	108
1,5	4,0	22	5,15	21	8,15	23	158
2	3,5	23	4,45	28	7,05	24	208
2,5	3,15	22	4,0	23	6,3	32	258
3,5	2,65	23	3,35	28	5,35	42	358
5	2,2	20	2,8	25	4,45	47	508
7,5	1,8	30	2,3	23	3,65	45	758
10	1,55	41	2,0	24	3,15	43	109
15	1,3	39	1,6	27	2,55	40	159
20	1,1	37	1,4	50	2,2	43	209
25	1,0	46	1,25	49	2,0	44	259
35	0,84	60	1,07	49	1,7	75	359
50	0,70	86	0,89	105	1,4	86	509
75	0,58	82	0,73	99	1,15	75	759
100	0,50	109	0,63	132	1,0	143	101
150	0,40	103	0,51	125	0,81	135	151
200	0,35	137	0,44	105	0,70	180	201
250	0,31	108	0,40	132	0,63	142	251
350	0,26	151	0,33	184	0,53	199	351
500	0,22	136	0,28	165	0,44	179	501
750	0,18	204	0,23	157	0,36	268	751
1 000	0,15	172	0,20	210	0,31	226	102
1 500	0,13	258	0,16	214	0,25	340	152
2 000	0,11	345	0,14	286	0,22	286	202
2 500	0,10	272	0,12	357	0,20	357	252
3 500	0,08	380	0,10	392	0,17	316	352
5 000	0,07	343	0,09	417	0,14	450	502
7 500	0,06	513	0,07	395	0,11	428	752
10 000			0,06	528	0,10	570	103

Note: Spare carbon brushes are available. Catalogue numbers:

4322 048 03670 for 25 W types,
4322 048 01710 for 40 W types, $R_n \leqslant 10\ \Omega$,
4322 048 03530 for 40 W types, $R_n > 10\ \Omega$,
4322 048 03540 for 100 W types.

COMPOSITION OF THE CATALOGUE NUMBER

2322 ... .

095 for 25 W type
096 for 40 W type
097 for 100 W type

code for R_n, see Table 1

21 for spindle length L = 17 mm
31 for spindle length L = 36 mm

GANGING

For ganging two load potentiometers, the following set of coupling parts is available, packed in a plastic bag:

1 bracket D,
1 threaded spindle B,
1 cross pin C,
1 coupling E,
2 set screws K,
retaining rings

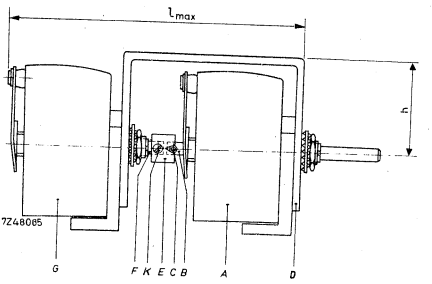


Fig. 7.

Catalogue numbers. Dimensions (Fig. 7) are:

potentiometers		catalogue number coupling set	l_{max} mm	h mm
25 W	2322 095 21 ... + 2322 095	4322 048 06480	83	22
40 W	2322 096 21 ... + 2322 096	4322 048 06490	95,5	29,5
100 W	2322 097 21 ... + 2322 097	4322 048 06500	129,5	40

Ganging procedure (see Fig. 7)

The central screw H (Figs 1-3) is removed from the potentiometer A and replaced by spindle B having a threaded end that is firmly tightened; the other extremity of B is provided with the round cross-pin C. Thereupon, potentiometer A is attached to the bracket D by means of the hexagonal nut, and coupling E is slipped over the extruding end of B.

The second potentiometer (G) having a spindle (F) with standard length L = 17 mm, is now attached to the bracket as well. After placing the runners of both potentiometers in the same position, the coupling is affixed to F by means of the two radial set screws K in the coupling.

When the spindle of potentiometer A is rotated, potentiometer G rotates simultaneously through the intermediary of cross pin C and a V-shaped groove in the coupling. The potentiometers and the coupling should be adjusted so as to obtain a smoothly running assembly.

Mounting

The front face of bracket D has two 4 mm threaded holes, which allow of fitting two screws through the mounting panel to prevent the ganged assembly from turning. The panel should be provided with apertures according to Fig. 8.

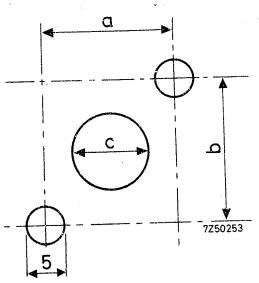


Fig. 8.

	dimensions in mm			
	a	b	c	panel thickness
25 W	18	20	10,5	⩽3
40 W	18	30	10,5	⩽3
100 W	22	30	10,5	⩽2

WIREWOUND POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E6-series), linear law	2,2 to 10 000 Ω
Maximum permissible dissipation at 40 °C	1,5 W
Climatic category (IEC 68)	25/085/21
Plastic housing, plastic spindle	

APPLICATION

In industrial electric and electronic equipment where accurate and gradual resistance regulation and high stability are required.

DESCRIPTION

The potentiometer consists of a single layer of resistance wire wound on an insulated former and housed in a moulded plastic case, which at one end has a plastic cover plate and at the other end a press-fitted threaded metal bushing supporting the plastic spindle.

Terminals a and c (see Fig. 1) are the end terminals which are of a snap-on type; b is the central terminal which is connected to the slider through a collector ring.

The case has a locating slot for mounting purposes.

The potentiometer is dust-proof sealed.

Outlines

Dimensions in mm

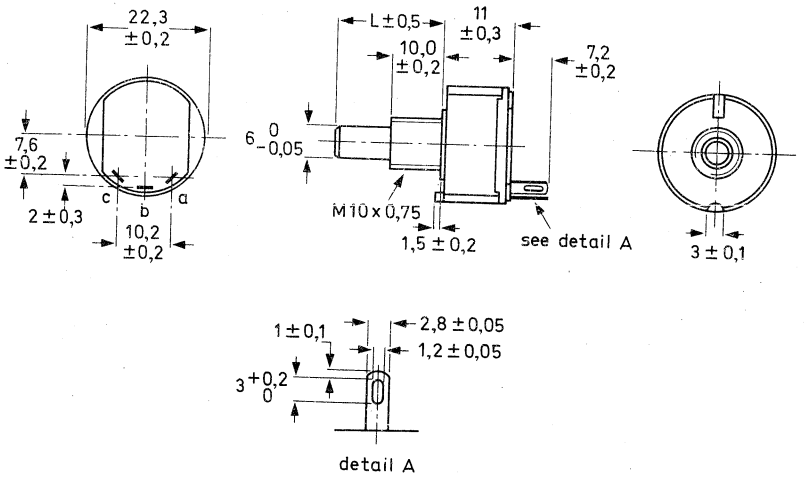


Fig. 1a Potentiometer with plain spindle; spindle length L is 17 mm, 20 mm, 30 mm or 60 mm.

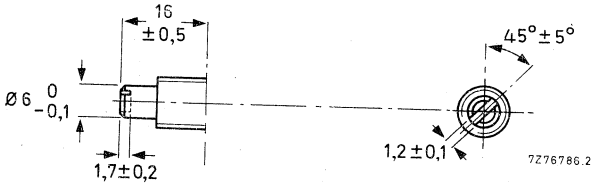


Fig. 1b Spindle with screwdriver slot; spindle fully counter-clockwise.

MOUNTING

The potentiometer can be mounted on a panel with an hexagonal nut which is supplied with the potentiometer (catalogue number of nut 4322 047 00350). The maximum torque for tightening the nut is 3,5 Nm. See Fig. 2 for the required mounting holes in the panel. A washer has to be used if the panel thickness is less than 1 mm as otherwise it might not be possible to secure the nut.

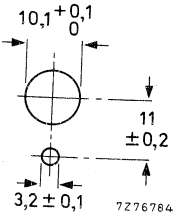


Fig. 2 Mounting holes.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 25 °C, an air pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.
For definitions of properties and test methods, see IEC 393–1.

Nominal resistance (R_n) between a and c	2,2 to 10 000 Ω, see Table 1
Resistance law	linear
Tolerance on R_n	±10%
Resistance at beginning and end	⩽ 2% of R_{total} or 300 mΩ whichever is greater
R gradient	0% of R_{total}
Resistance at 50% of effective angle of rotation	50 ± 2% of R_{total}
Contact resistance between resistance element and slider	⩽ 1% of R_{total} or 200 mΩ whichever is greater
Temperature coefficient	see Table 1
Maximum dissipation between a and c (Fig. 3)	
at T_{amb} = 40 °C	1,5 W
at T_{amb} = 70 °C	1,0 W
Resolution	
R_n = 2,2 to 68 Ω	< 1,5% of R_{total}
R_n > 68 Ω	< 0,8% of R_{total}
Maximum slider current	1 A
Maximum working voltage (a.c.) between case and resistance element	500 V
Test voltage (a.c.) between bearing bushing and resistance element	⩽ 2000 V
Insulation resistance	> 1000 MΩ
Ambient temperature range	–25 to +85 °C
Storage temperature range	–25 to +85 °C
Mechanical angle of rotation	270 ± 5°
Effective angle of rotation	265 ± 5°
Operating torque	3,5 to 20 mNm
Maximum end stop torque	800 mNm
Maximum axial force (push and pull)	100 N

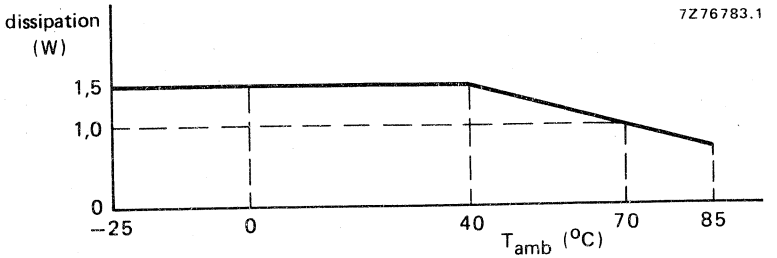


Fig.3 Dissipation as a function of ambient temperature.

Table 1

nominal resistance Ω	temperature coefficient 10^{-6}/K	number of turns ±25%	code in catalogue number
2,2	−25 to +600	110	228
3,3		108	338
4,7		95	478
6,8		136	688
10		126	109
15		194	159
22		113	229
33		134	339
47		120	479
68	−25 to +25	172	689
100		160	101
150		178	151
220	0 to +140	165	221
330		155	331
470		222	471
680		200	681
1 000		297	102
1 500		287	152
2 200		420	222
3 300		398	332
4 700	−20 to + 20	408	472
6 800		366	682
10 000		538	103

MARKING

The potentiometers are marked at the rear with nominal resistance value (according to IEC 62), resistance tolerance, power rating, production code (period and year) and name of manufacturer.

COMPOSITION OF THE CATALOGUE NUMBER

2322 018 . 1 . . .

figure indicating the spindle type
0 = slotted spindle
2 = plain spindle, L = 17 mm
3 = plain spindle, L = 20 mm
4 = plain spindle, L = 30 mm
5 = plain spindle, L = 60 mm
see Fig.1a

code for resistance value, see Table 1

figure indicating the tolerance of ±10%

TESTS AND REQUIREMENTS

IEC 393–1 test method	name of test	procedure (quick reference)	requirements
Ta	Solderability	235 ± 2 °C, 2 s.	95% of surface.
Tb (method 1B)	Resistance to soldering heat	350 °C, 3,5 s.	No damage; $\Delta R_{tot}/R_{tot} \leqslant 2\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −25 °C and ½ h at +85 °C.	$\Delta R_{tot}/R_{tot} \leqslant 3\%$.
Fc	Vibration	10 to 55 Hz, 10g, 3 directions, 2 h per direction.	$\Delta R_{tot}/R_{tot} \leqslant 2\%$. 2%. No interruptions > 100 μs.
Ba, D, Aa	Climatic sequence	16 h at 85 °C. 24 h at 55 °C, R.H. 95 to 100%. 2 h at −25 °C. 24 h at 55 °C, R.H. 95 to 100%. 1 h reconditioning at 25 °C	No damage; $R_{min} \leqslant 2\% R_{tot}$; $\Delta R_{tot}/R_{tot} \leqslant 5\%$. Insulation resistance > 100MΩ. Test voltage for 1 min is 2000 V (a.c.). Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
Ca	Damp heat	21 days at 40 °C, R.H. 90 to 95%.	
	Endurance	1000 h at 70 °C, 1,5 W loaded, 1,5 h in and 0,5 h out.	$\Delta R_{tot}/R_{tot} \leqslant 5\%$. Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
	Mechanical endurance	15 000 cycles ($R_n \leqslant 4{,}7$ kΩ) or 10 000 cycles ($R_n > 4{,}7$ kΩ), 90% of effective angle of rotation; unloaded.	$\Delta R_{tot}/R_{tot} \leqslant 5\%$. Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
	Inflammability		Self-extinguishing within 15 s after removal from the flame.

WIREWOUND POTENTIOMETERS

QUICK REFERENCE DATA

Linear resistance law	
Resistance range	2,2 to 22 000 Ω
Maximum permissible dissipation	
at 40 °C	3 W
at 70 °C	2 W
Potentiometers 2322 003	with solder tags at the side
Potentiometers 2322 010	with solder tags at the bottom

APPLICATION

In electric and electronic equipment where accuracte and gradual resistance control and high stability are required.

CONSTRUCTION

The potentiometer consists of a single layer of resistance wire wound on a strip of resin-bonded paper and is housed in a nickel-plated brass case with a bottom of black synthetic resin.

The solder tags a and c (see Figs 1 to 4) are connected to the ends of the resistance element: solder tag b is connected, via a central bush, to the sliding contact which is insulated from the steel spindle.

The case is attached to a support of moulded zinc, which has a location pip, an end stop, and a threaded spindle bush.

The whole unit is sealed dust-proof.

Note: A version with pins for printed-wiring can be supplied on request (see Fig. 6).

Outlines

Dimensions in mm

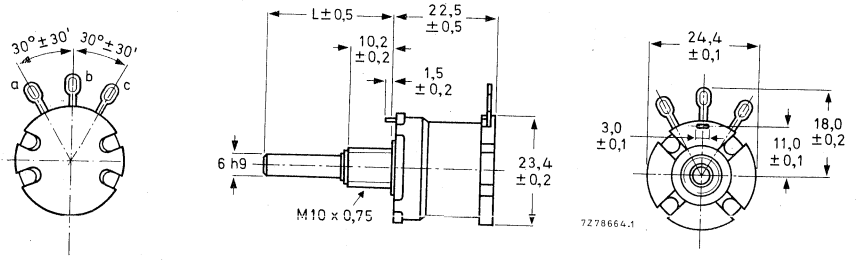


Fig. 1 Potentiometers 2322 003 . . . . . with plain spindle. The spindle length L is 17, 20, 30 or 60 mm.

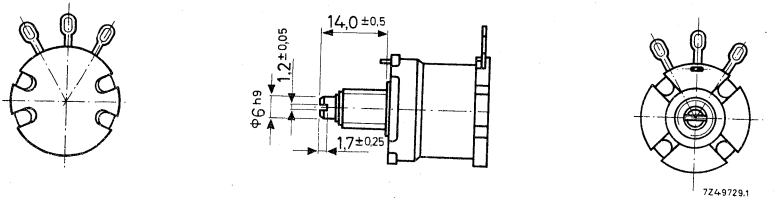


Fig. 2 Potentiometers 2322 003 . . . . . with spindle with screwdriver slot. Dimensions are identical to those in Fig. 1 except as shown.

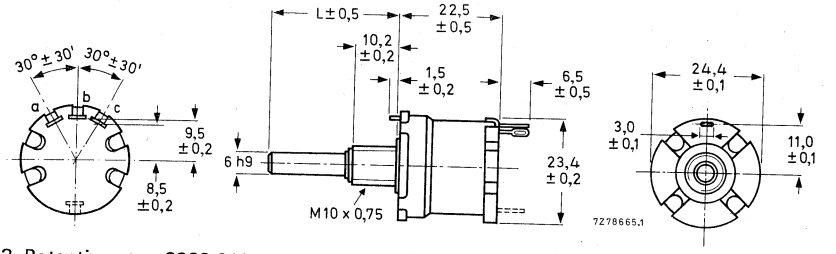


Fig. 3 Potentiometers 2322 010 . . . . . with plain spindle. The spindle length L is 17, 20, 30 or 60 mm.

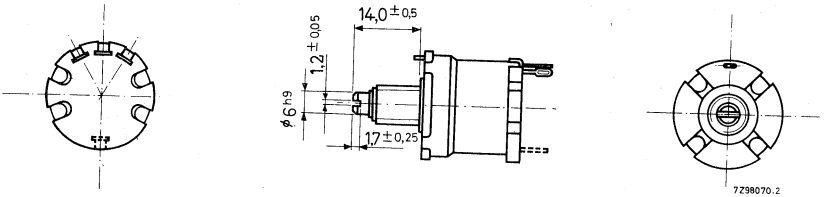


Fig. 4 Potentiometers 2322 010 . . . . . with spindle with screwdriver slot. Dimensions are identical to those in Fig. 3 except as shown.

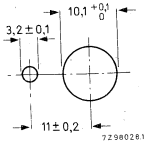


Fig. 5 Mounting holes.

The potentiometers can be mounted on a panel by means of an hexagonal nut which is supplied with each potentiometers (catalogue number of the nut 4322 047 00350). The minimum thickness of the chassis is 1 mm. The maximum torque for tightening is 3,5 Nm.

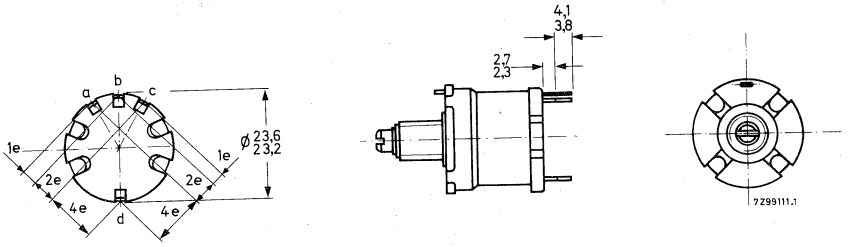


Fig. 6 Potentiotiometer with pins for printed-wiring.

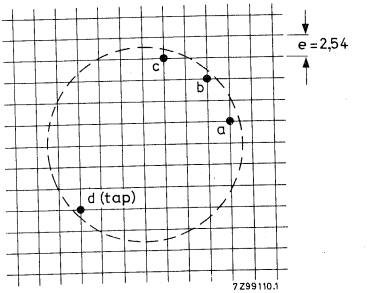


Fig. 7 Hole pattern of the printed-wiring board.

TECHNICAL DATA

Unless otherwise specified all values apply at an ambient temperature of 20 ± 5 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.

Nominal resistance (R_n), measured between the tags a and c (see Figs 1 and 3)	see Table 1
Tolerance on the nominal resistance for $R_n \leq 47\ \Omega$ for $R_n > 47\ \Omega$	 ± 10% ± 5% and ± 10%
Resistance law	linear
Resistance at 50% of effective angle of rotation	50% ± 2% of R_{total}
Maximum permissible dissipation, the full length of the resistance element being used	see Fig. 8
Temperature coefficient of the resistance	see Table
Insulation resistance	> 1000 MΩ
Test voltage between spindle and tags for 1 mm	1000 V

Maximum working voltage between resistance element and case	500 V peak
Working temperature range	−10 to +85 °C
Climatic category, IEC 68	10/085/21
Number of windings	see Table 1
Effective angle of rotation	290 ± 10°
Mechanical angle of rotation	300 ± 5°
Operating torque	7,5 to 20 mNm
End stop torque	⩽ 800 mNm
Maximum axial spindle load	50 N
Life	
for $R_n \leqslant 6{,}8\ k\Omega$	in excess of 25 000 cycles
for $R_n > 6{,}8\ k\Omega$	in excess of 10 000 cycles

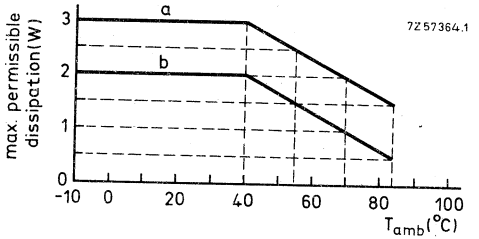


Fig. 8 Maximum permissible dissipation as a function of the ambient temperature.
Curve a: for potentiometers mounted on a metal chassis of 100 mm x 100 x 1 mm.
Curve b: for potentiometers mounted on an insulating panel.

COMPOSITION OF THE CATALOGUE NUMBER

2322 0 . . . . .

style
03 = potentiometer with solder tags at the side
10 = potentiometer with solder tags at the bottom

spindle type
0 = slotted spindle
2 = plain spindle; length 17 mm
3 = plain spindle; length 20 mm
4 = plain spindle; length 30 mm
5 = plain spindle; length 60 mm

code for resistance value, see Table 1

tolerance and tap
1 = ± 10%
2 = ± 5% ($R_n > 47\ \Omega$)
6 = ± 10%, with tap*
7 = ± 5% ($R_n > 47\ \Omega$) with tap*

* Tap at 50% of the effective angle of rotation.

Table 1

resistance Ω	temperature coefficient 10^{-6}/K	number of windings ± 25%	code in catalogue number
2,2	0 to +600	60	228
3,3		55	338
4,7		79	478
6,8		71	688
10		105	109
15		102	159
22		150	229
33	−25 to +600	141	339
47		103	479
68	−25 to +25	96	689
100		142	101
150		128	151
220		188	221
330	−25 to +140	182	331
470		191	471
680	0 to +140	172	681
1 000		155	102
1 500		234	152
2 200		227	222
3 300		342	332
4 700		302	472
6 800		438	682
10 000	−20 to +140	413	103
15 000		497	153
22 000		448	223

WIREWOUND POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E6-series), linear law	2,2 to 10 000 Ω
Maximum permissible dissipation at 40 °C	2 W
Climatic category (IEC 68)	25/085/21
Metal housing, metal spindle	

APPLICATION

In professional electric and electronic equipment where accurate and gradual resistance regulation and high stability are required.

DESCRIPTION

The potentiometer consists of a single layer of resistance wire wound on an insulated former and is housed in a metal case which at one end has a plastic cover plate and at the other end a moulded zinc plate with integral threaded bushing and locating pip. The threaded bushing supports the spindle.

Terminals a and c (see Fig. 1) are the end terminals which are of a snap-on type; b is the central terminal which is connected to the slider through a collector ring and is insulated from the spindle.

The potentiometer is dust-proof sealed.

Outlines

Dimensions in mm

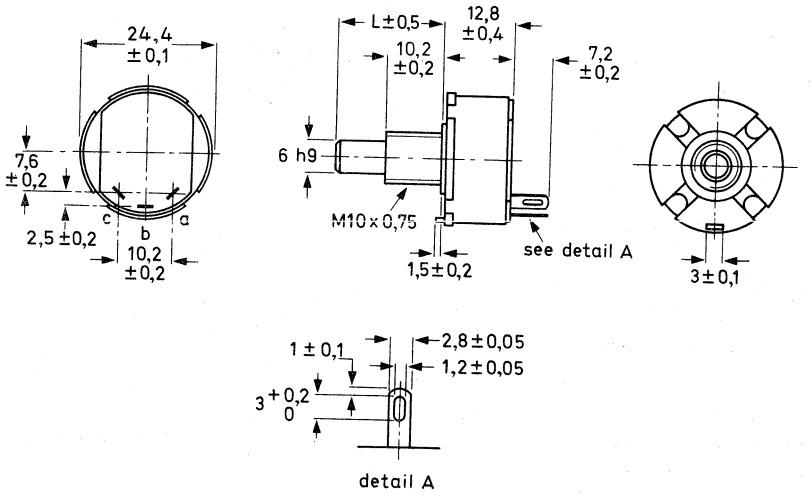


Fig. 1a Potentiometer with plain spindle; spindle length L is 17 mm, 20 mm, 30 mm or 60 mm.

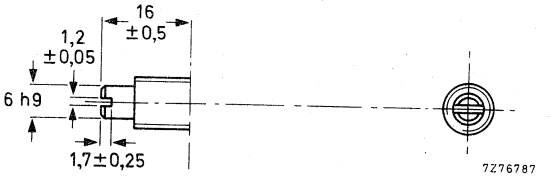


Fig. 1b Spindle with screwdriver slot; position of slot is at random.

MOUNTING

The potentiometer can be mounted on a panel with an hexagonal nut supplied with the potentiometer (catalogue number of nut 4322 047 00350). The maximum torque for tightening the nut is 3,5 Nm. See Fig. 2 for the required mounting holes in the panel.

A washer has to be used if the panel thickness is less than 1 mm as otherwise it might not be possible to secure the nut.

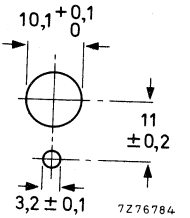


Fig. 2 Mounting holes.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 25 °C, an air pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.
For definitions of properties and test methods, see IEC 393–1.

Nominal resistance (R_n) between a and c	2,2 to 10 000 Ω, see Table 1
Resistance law	linear
Tolerance on R_n	±5%
Resistance at beginning and end	⩽ 2% of R_{total} or 300 mΩ whichever is greater
R gradient	0% of R_{total}
Resistance at 50% of effective angle of rotation	50 ± 2% of R_{total}
Contact resistance between resistance element and slider	⩽ 1% of R_{total} or 200 mΩ whichever is greater
Temperature coefficient	see Table 1
Maximum dissipation between a and c (Fig. 3)	
at T_{amb} = 40 °C	1,5 W
at T_{amb} = 70 °C	1,0 W
Resolution	
R_n = 2,2 to 68 Ω	< 1,5% of R_{total}
R_n > 68 Ω	< 0,8% of R_{total}
Maximum slider current	1 A
Maximum working voltage (a.c.) between case and resistance element	500 V
Test voltage (a.c.) between case and resistance element	⩽ 1500 V
Insulation resistance	> 1000 MΩ
Ambient temperature range	−25 to +85 °C
Storage temperature range	−25 to +85 °C
Mechanical angle of rotation	270 ± 5°
Effective angle of rotation	265 ± 5°
Operating torque	7,5 to 20 mNm
Maximum end stop torque	800 mNm
Maximum axial force (push and pull)	100 N

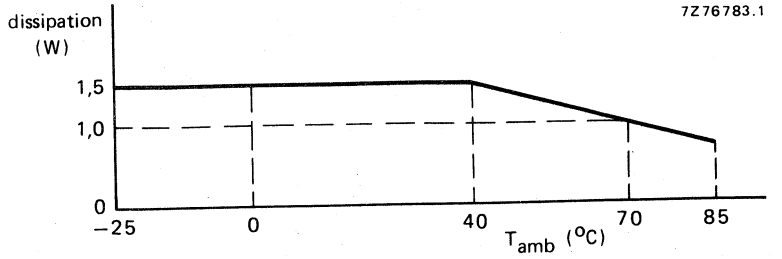


Fig. 3 Dissipation as a function of ambient temperature.

Table 1

nominal resistance Ω	temperature coefficient 10^{-6}/K	number of turns ±25%	code in catalogue number
2,2	−25 to +600	110	228
3,3		108	338
4,7		95	478
6,8		136	688
10		126	109
15		194	159
22		113	229
33		134	339
47		120	479
68	−25 to +25	172	689
100		160	101
150		178	151
220	0 to +140	165	221
330		155	331
470		222	471
680		200	681
1 000		297	102
1 500		287	152
2 200		420	222
3 300		398	332
4 700	−20 to + 20	408	472
6 800		366	682
10 000		538	103

MARKING

The potentiometers are marked at the rear with nominal resistance value (according to IEC 62), resistance tolerance, power rating, production code (period and year) and name of manufacturer.

COMPOSITION OF THE CATALOGUE NUMBER

2322 020 . 2 . . .

figure indicating the spindle type
0 = slotted spindle
2 = plain spindle, L = 17 mm
3 = plain spindle, L = 20 mm
4 = plain spindle, L = 30 mm
5 = plain spindle, L = 60 mm

see Fig.1a

code for resistance value, see Table 1

figure indicating the tolerance of ±5%

TESTS AND REQUIREMENTS

IEC 393–1 test method	name of test	procedure (quick reference)	requirements
Ta	Solderability	235 ± 2 °C, 2 s.	95% of surface
Tb (method 1B)	Resistance to soldering heat	350 °C, 3,5 s.	No damage; $\Delta R_{tot}/R_{tot} \leqslant 2\%$.
Na	Rapid change of temperature	5 cycles of ½ h at −25 °C and ½ h at +85 °C.	$\Delta R_{tot}/R_{tot} \leqslant 3\%$.
Fc	Vibration	10 to 55 Hz, 10g, 3 directions, 2 h per direction.	$\Delta R_{tot}/\Delta R_{tot} \leqslant 2\%$. No interruptions $> 100\ \mu s$.
Ba, D, Aa	Climatic sequence	16 h at 85 °C. 24 h at 55 °C, R.H. 95 to 100%. 2 h at −25 °C. 24 h at 55 °C, R.H. 95 to 100%. 1 h reconditioning at 25 °C.	No damage; $R_{min} \leqslant 2\%\ R_{tot}$; $\Delta R_{tot}/R_{tot} \leqslant 5\%$. Insulation resistance $> 100\ M\Omega$. Test voltage for 1 min is 1500 V (a.c.). Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
Ca	Damp heat	21 days at 40 °C, R.H. 90 to 95%.	
	Endurance	1000 h at 70 °C, 1,5 W loaded, 1,5 h in and 0,5 h out.	$\Delta R_{tot}/R_{tot} \leqslant 5\%$. Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
	Mechanical endurance	15 000 cycles ($R_n \leqslant 4{,}7\ k\Omega$) or 10 000 cycles ($R_n > 4{,}7\ k\Omega$), 90% of effective angle of rotation; unloaded.	$\Delta R_{tot}/R_{tot} \leqslant 5\%$. Continuity of resistance (after 4 cycles): $\Delta V/V < {}^{+7\%}_{-5\%}$.
	Inflammability		Self-extinguishing within 15 s after removal from the flame.

WIREWOUND POTENTIOMETERS

QUICK REFERENCE DATA

Linear resistance law	
Resistance range	10 Ω to 50 000 Ω
Maximum permissible dissipation	
at 40 °C	3 W
at 70 °C	1,5 W

APPLICATION

In electric and electronic equipment where accurate and gradual resistance control and high stability are required. Due to the large outer diameter, a very good resolution has been obtained.

CONSTRUCTION

The potentiometer consists of a single layer of resistance wire wound on a strip of resin-bonded paper and is housed in a case of black synthetic resin, which is dust-proof seated by a metal bottom.

The solder tags a and c (see Figs 1 and 2) are connected to the ends of the resistance element. A resilient slider, which is insulated from the steel spindle, slides over the flat top of the winding when the spindle is turned. The slider makes a sliding contact with the solder tag b by means of a slip ring. A stop prevents the slider from overrunning the resistance element.

Outlines

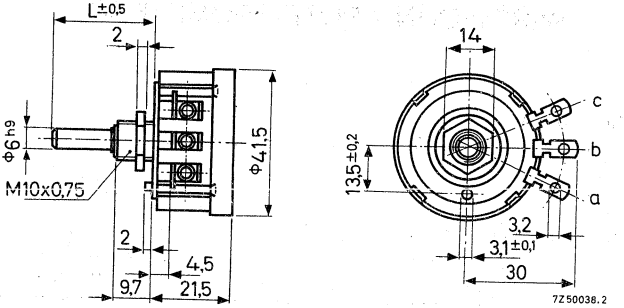


Fig. 1 Potentiometer with plain spindle. The spindle length L is 20, 25, 30, 35 or 80 mm.

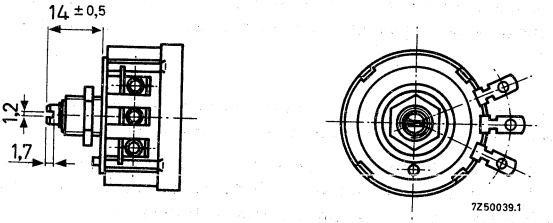


Fig. 2 Potentiometer with spindle with screwdriver slot. Dimensions are identical to those in Fig. 1 except as shown.

Mounting

The potentiometers can be mounted on a panel with an hexagonal nut which is supplied with each potentiometer (catalogue number of nut 4322 047 00350). The maximum torque for tightening is 3,5 Nm.

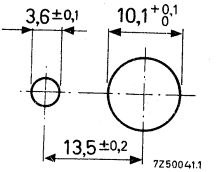


Fig. 3 Mounting holes.

TECHNICAL DATA

Unless otherwise specified all values apply at an ambient temperature of 20 ± 5 °C, an atmospheric pressure of 93 to 106 kPa and a relative humidity of 45 to 75%.

Nominal resistance (R_n), measured between the tags a and c (see Figs 1 and 2)	see Table 1
Tolerance on the nominal resistance	
for $R_n \leqslant 75\ \Omega$	± 10%
for $R_n > 75\ \Omega$	± 5% and ± 10%
Resistance law	linear
Resistance at 50% of effective angle of rotation	50% ± 2% of R_{total}
Maximum permissible dissipation, the full length of the resistance element being used	
at $T_{amb} = 40$ °C	3 W
at $T_{amb} < 40$ °C	see Fig. 4
Temperature coefficient of the resistance	see Table 1
Insulation resistance	> 100 MΩ
Test voltage r.m.s. for 1 min	2000 V
Maximum peak working voltage between mounting bush and solder tags	1000 V
Ambient temperature range	−55 to + 100 °C
Number of windings	see Table 1
Effective angle of rotation	280 ± 4°
Mechanical angle of rotation	300 ± 2°
Operating torque	10 to 30 mNm
End stop torque	⩽ 800 mNm
Life	
for $R_n \leqslant 10$ kΩ	in excess of 25 000 cycles
for $R_n > 10$ kΩ	in excess of 10 000 cycles

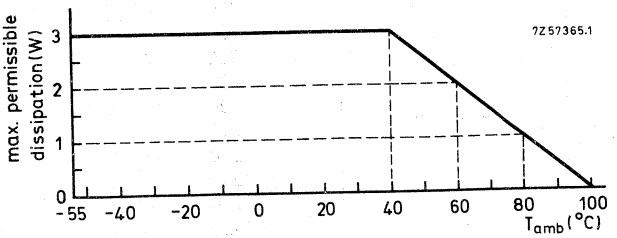


Fig. 4 Maximum permissible dissipation as a function of the ambient temperature.

COMPOSITION OF THE CATALOGUE NUMBER

2322 004 . . . . .

figure indicating the spindle type
2 = spindle with screwdriver slot
3 = plain spindle; length 20 mm
4 = plain spindle; length 25 mm
5 = plain spindle; length 30 mm
6 = plain spindle; length 35 mm
7 = plain spindle; length 80 mm

code for resistance value, see Table 1

figure indicating the tolerance
1 = ± 10%
2 = ± 5% ($R_n > 75\ \Omega$)

Table 1

resistance Ω	temperature coefficient 10^{-6}/K	number of windings ± 25%	code in catalogue number
10	0 to +600	160	109
15		240	159
20		200	209
25		250	259
35		220	359
50		320	509
75		300	759
100	−25 to +25	200	101
150		190	151
200		260	201
250		320	251
350		280	351
500		410	501
750		380	751
1 000		510	102
1 500	0 to +140	360	152
2 000		480	202
2 500		380	252
3 500		530	352
5 000		750	502
7 500		710	752
10 000		600	103
15 000		560	153
20 000		710	203
25 000		950	253
35 000	−20 to +20	1 050	353
50 000		1 200	503

CARBON POTENTIOMETERS

B

INTRODUCTION

There are two main groups in our range of carbon potentiometers.

Preset potentiometers are mainly used for eliminating circuit tolerances during the assembly of electronic equipment or the readjustment of electronic circuits at a later stage. Five series of preset potentiometers are available:

- CTP18-series: maximum dissipation 0,25 W, dimensions approx. 18 x 20 mm.
- CTP14-series: maximum dissipation 0,2 W, dimensions approx. 14 x 17 mm.
- CTP10-series: maximum dissipation 0,1 W, dimensions approx. 10 x 10 mm.
- ECP10: maximum dissipation 0,1 W, dimensions approx. 10 x 12 mm.
- CMP-series: rectangular multi-turn potentiometers designed for use with television tuners, dimensions approx. 43,5 x 8 x 5 mm.

Control potentiometers are widely used in all kinds of electronic equipment, e.g. for volume, tone, brightness and balance control. The following series of control potentiometers are available:

- CP23-series: maximum dissipation 0,25 W (linear law), or 0,125 W (logarithmic law), diameter approx. 23 mm. Single, tandem, twin, and triple types, with or without switch.
- CP16-series: maximum dissipation 0,1 W (linear law), or 0,05 W (logarithmic law), diameter approx. 16 mm. Single and tandem types, with or without switch.
- CP13-series (knob potentiometers): maximum dissipation 0,05 W, diameter approx. 13 mm.
- PP17-series (potpack potentiometers), maximum dissipation 0,2 W, dimensions approx. 17 x 22 mm. Single and tandem types, with or without switch.
- PP17M-series, PP17MT-series: similar to PP17-series, but in modular form without spindle.
- CSP60-series (slide potentiometers): maximum dissipation 0,4 W (linear law), or 0,2 W (logarithmic law), dimensions approx. 87 x 16 x 10,2 mm. Single and tandem types.
- CSP40-series (slide potentiometers): maximum dissipation 0,25 W (linear law), or 0,125 W (logarithmic law), dimensions approx. 68 x 16 x 10,2 mm. Single and tandem types.
- CSP25-series (slide potentiometers): dimensions approx. 43,5 x 8 x 5 mm; types with linear or logarithmic law. Single types only.

GLOSSARY OF TERMS

Preset potentiometers – Potentiometers of simple construction, in general without spindle, encapsulation and mounting facilities. They are specially suited for use where a comparatively small number of movements are required during their life. Usually for mounting on p.w. boards.

Control potentiometers – Potentiometers of more complicated construction, with spindle, (rotary types) or slider (straight line action types), encapsulation and mounting facilities and suited for use where a large number of movements are required during their life.

Single, tandem, twin, triple potentiometers

Single potentiometers are control potentiometers comprising one resistor unit. **Tandem potentiometers** are control potentiometers comprising two identical resistor units controlled by one spindle. **Twin potentiometers** are control potentiometers comprising two resistor units controlled by separate concentric spindles. **Triple potentiometers** are control potentiometers consisting of one single and one tandem potentiometer, controlled by separate concentric spindles.

Potpack

Compact, rectangular potentiometers. Either single or tandem types.

Potpack module

Basic element of Potpack-series consisting of a module with full electrical and primary mechanical functions.

Multi-turn potentiometers

Preset carbon potentiometers with knob or gearwheel, designed for fine resistance adjustment, usually in diode tuning. Up to 40 rotations of spindle.

Slide carbon potentiometers

Control potentiometers with a straight line action.

Switches – Mains-voltage or battery-voltage switches, fitted to the potentiometers and usually controlled by the potentiometer spindle.

Nominal resistance (R_n) – Nominal value of the resistance between the end terminals a and c (Fig. 1), with the slider at end-stop position.

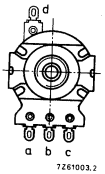
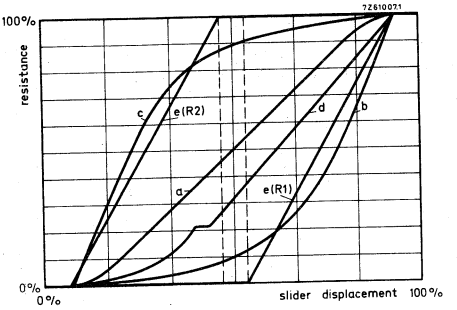


Fig. 1 Rotary potentiometer viewed from the spindle.

Resistance law — Relationship between the resistance measured between the slider terminal (b) and the designated end terminal (a), and the mechanical position of the actuating device (Fig. 2).



a = linear;
b = logarithmic;
c = reversed logarithmic;
d = with tap;
e = balance.

Fig. 2 Resistance laws.

Terminal resistance — Minimum resistance that can be obtained between either end terminals (a or c) and the slider terminal b (see Fig. 3). Where there is no measurable change of resistance between the end stop and the point where the minimum effective resistance is observed, the terminal resistance and the minimum effective resistance become the same.

Minimum resistance at the tap — Minimum adjustable resistance between the tap terminal d (Fig. 1) and the slider terminal b.

Contact resistance (R_c) — Resistance between resistance element and slider contact.

Contact resistance variation (CRV) — Change of the resistance between the resistance element and the slider contact, when it is moved at a defined speed.

Maximum attenuation — Maximum adjustable attenuation when the potentiometer is used as an attenuator (see Fig. 3).

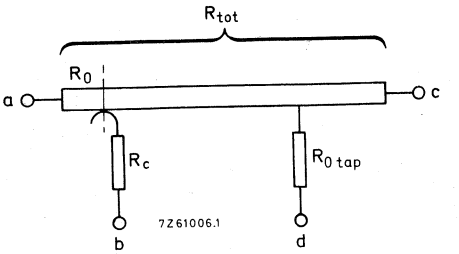


Fig. 3 Diagram of potentiometer; spindle in fully counter-clockwise position.
Terminal resistance: $(R_o + R_c)\ \Omega$.
Maximum attenuation: $20 \log \frac{R_o}{R_{tot}}$ dB.
(The value of R_c is negligible.)

Maximum dissipation (P_{max}) — Maximum amount of power which can be dissipated at a given ambient temperature, when the potentiometer is continuously loaded between the end terminals a and c (Fig. 1) and mounted on a steeel panel of 100 x 100 x 1,5 mm (or on a printed circuit board for types with printed-wiring pins).

Maximum voltage (E_{max}) — The maximum voltage that may be applied is calculated from maximum dissipation (P_{max}) and nominal resistance (R_n): $E_{max} = \sqrt{P_{max} \cdot R_n}$, provided that the limiting element voltage is not exceeded.

Limiting slider current — Maximum current that may be passed between resistance element and slider contact.

Insulation resistance — Resistance measured between interconnected terminals and all other external metal parts.

Test voltage — Voltage to be applied for one minute between interconnected terminals and other external metal parts.

Ganging tolerance — Maximum difference between the adjusted resistances of the two sections of a tandem potentiometer (expressed in dB).

Mechanical angle of rotation — The full extent of the travel of the actuating device of a rotary potentiometer between the end stops (Fig. 4).

Effective angle of rotation — That angle throughout which the resistance law of a rotary potentiometer is applicable (Fig. 4).

Switching angle — That angle over which the switch of a rotary potentiometer has to be actuated from the off to the on position, or vice versa (Fig. 4).

Backlash of the rotary switch — That angle over which the spindle of a rotary potentiometer has to be rotated before actuating the switch from the off to the on position (Fig. 4).

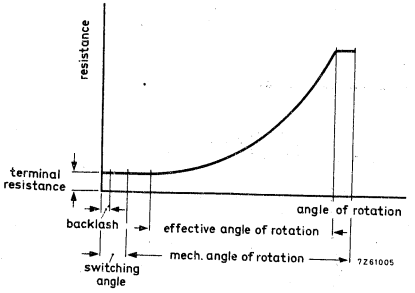


Fig. 4a.

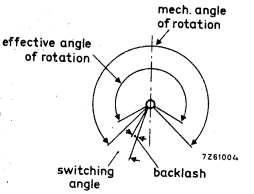


Fig. 4b.

Backlash of potentiometer with push-pull switch — That angle over which the spindle can be rotated before it causes any resistance change.

SURVEY

For ordering use the 12-digit catalogue numbers, see Composition of the catalogue number of the relevant potentiometer.

MULTI-TURN CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Nominal resistance	
linear law	100 Ω – 4,7 MΩ
logarithmic law	1 kΩ – 2,2 MΩ
special law	100 kΩ
Number of turns of spindle	
potentiometers CMP10	10
potentiometers CMP20	20
potentiometers CMP40	40
Climatic category (IEC 68)	25/070/21

APPLICATION

The potentiometers are for preset tuning adjustment in variable capacitance diode television tuners, but can also be used for variable capacitance diode tuning radio receivers, or for any other fine resistance adjustment.

DESCRIPTION

A straight carbon track is fitted on to a base plate of resin-bonded paper, which is mounted in a housing of black synthetic resin. The terminals are suited for mounting on printed-wiring boards. The slider is activated by a silvered threaded spindle. The potentiometer will not be damaged if the spindle is turned beyond its extreme position. The potentiometers can be supplied with various adjustments and with or without a scale indicator.

All versions are available with linear or logarithmic resistance law; the 100 kΩ versions are also available with special resistance law.

COMPOSITION OF THE CATALOGUE NUMBER

2322 41 . . . . .

code for number of turns of spindle
2 = 20 turns, type CMP20
3 = 10 turns, type CMP10
4 = 40 turns, type CMP40

code for indicator, see Indicators

code for nominal resistance value, see Table 1

code for adjustment provision, see Adjustment provisions.

MECHANICAL DATA

Dimensions of the housing (mm)

The housing has been drawn without scale indicator and adjustment provision; these parts are described in the relevant paragraph.

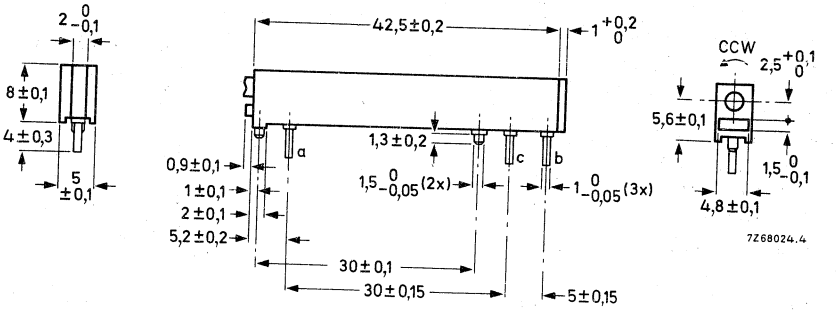


Fig. 1 Terminals a and c are connected to the ends of the carbon track; terminal b is connected to the slider contact.

Operating temperature range	−25 to + 70 °C
Climatic category (IEC 68)	25/070/21
Operating torque	1,5 to 10 mNm
Number of turns of spindle	
potentiometers CMP10	9½ ± ½
potentiometers CMP20	19 ± ½
potentiometers CMP40	38 ± 1
Maximum permissible axial spindle load (push and pull)	⩽ 2,5 N
Mechanical travel of slider contact	25,6 ± 0,3 mm
Effective travel of slider contact	24 − 1 mm
Solderability (to IEC 68-2, test T)	230 ± 10 °C, for 2 ± 0,5 s
Thermal shock test (to IEC 68-2, test T)	350 ± 10 °C, for 2 ± 0,5 s
Life (at a rate of 20 rev/min)	50 x in both directions + 3 rotations at both ends

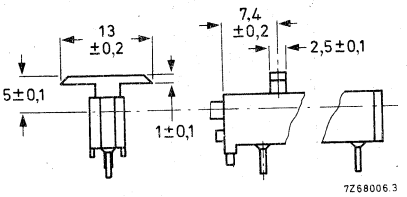
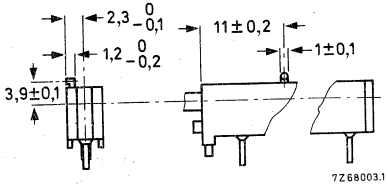
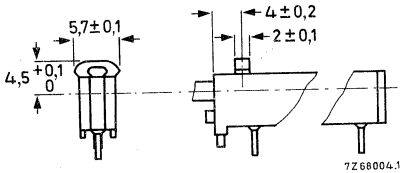
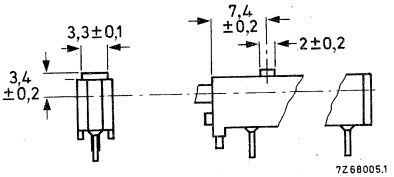
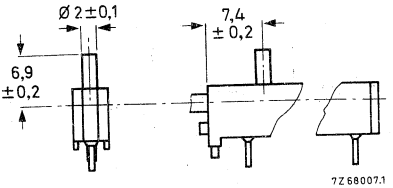
MOUNTING

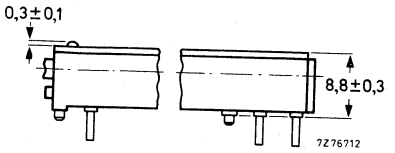
The terminals may be dip-soldered to a depth of 2 mm max in a solder bath of 260 °C max for 4 s max. When a soldering bit is used, its temperature must not exceed 360 °C for 1,5 s and neither axial nor radial stress must be exerted on the terminals.

MARKING

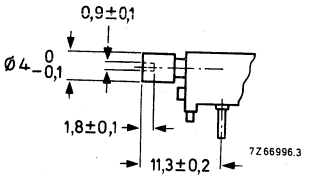
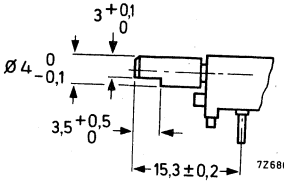
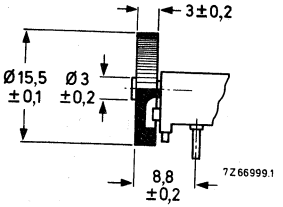
The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

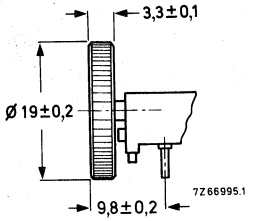
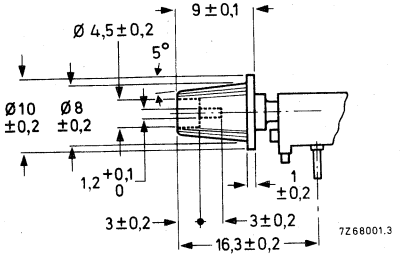
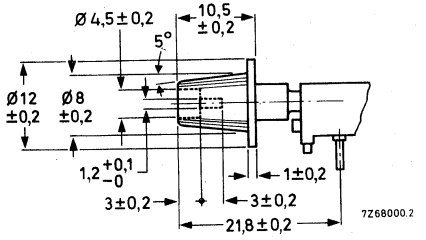
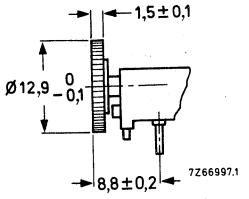
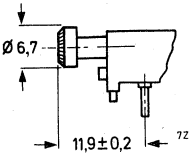
Indicators

type	colour	code in catalogue number 2322 41 . . . . .
	red	1
	red	2
	red	3
	yellow	4
	red	5

type	colour	code in catalogue number 2322 41 . . . . .
without indicator		0
without indicator, with black dust cover on the housing 		8

Adjustment provisions

type	colour	code in catalogue number 2322 41 . . . . .
	grey	51
	grey	52
 Knob: approx. 60 notches	red	61

type		colour	code in catalogue number 2322 41 . . . . .
	Knob: approx. 48 notches	black	62
		black	63
		black	64
	number of teeth = 24 tooth height = 1,2	white	82
	number of teeth = 12 shape according to DIN 867	black	83

ELECTRICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 1

nominal resistance R_n	resist. law	max. voltage (V d.c. or V a.c.) T_{amb} = 40 °C, $\Delta R < 20\%$ (note 1)	max. voltage (V d.c. or V a.c.) T_{amb} = 40 °C, $\Delta R < 10\%$ (note 1)	max. voltage (V d.c. or V a.c.) T_{amb} = 70 °C, $\Delta R < 20\%$ (note 1)	maximum terminal resistance	max. attenuation dB	limiting slider current mA	code in cat. no.
100 Ω	linear	5,5	5,0	3,9	10 Ω	20	55	01
220 Ω		8,1	7,4	5,7	20 Ω	20	37	02
470 Ω		11,8	10,8	8,4	35 Ω	30	25	03
1 kΩ		17	15,8	12,2	50 Ω	30	17	04
2,2 kΩ		26	23	18	100 Ω	40	11	05
4,7 kΩ		37	34	24	200 Ω	40	8	06
10 kΩ		53	47	37	300 Ω	40	5,3	07
22 kΩ		76	66	54	600 Ω	50	3,5	08
47 kΩ		108	91	76	1 kΩ	50	2,3	09
100 kΩ		152	122	107	2 kΩ	50	1,5	11
220 kΩ		217	166	153	3,5 kΩ	60	0,99	12
470 kΩ		306	216	216	6 kΩ	60	0,85	13
1 MΩ		425	274	300	10 kΩ	70	0,43	14
2,2 MΩ		600	330	420	20 kΩ	70	0,27	15
4,7 MΩ		840 (2)	340	590	50 kΩ	70	0,18	16
1 kΩ	logarithmic	10	8,9	7,1	10 Ω (5)	40	10 (3)	24
2,2 kΩ		14	12,8	10,2	20 Ω	50	6,8	25
4,7 kΩ		20	17,5	14,5	35 Ω	50	4,4	26
10 kΩ		29	24	20	50 Ω	50	2,9	27
22 kΩ		42	34	29	100 Ω	60	1,9	28
47 kΩ		59	47	41	200 Ω	60	1,3	29
100 kΩ		85	63	60	250 Ω	60	0,85	31
220 kΩ		122	87	86	500 Ω	70	0,55	32
470 kΩ		172	112	120	1 kΩ	70	0,37	33
1 MΩ		240	141	170	2 kΩ	80	0,24	34
2,2 MΩ		350	182	244	5 kΩ	80	0,16	35
100 kΩ	special	85	63	60	500 Ω	60	0,85 (4)	38

Notes

1. Measured after 1000 h.
2. Max. 600 V (a.c.).
3. Slider contact between 20 and 100% of R_{tot}. For slider contact positions between 0 and 20% of R_{tot} the values have to be multiplied by 6.
4. Slider contact between 20 and 100% of R_{tot}. For slider contact positions between 0 and 20% of R_{tot} the value has to be multiplied by 2,4.
5. Measured between terminals a and b.

Tolerance on nominal resistance	± 20%
Resistance law and tolerance	see Fig. 3
Maximum permissible dissipation (P_{max})	see Fig. 4
Contact resistance between carbon track and slider contact, the slider being moved 1 mm/s (see also Measurement of the contact resistance)	
linear law	⩽ 3% of R_{total}
logarithmic law,	
for 0 – 40% of effective travel	⩽ 0,75% of R_{total}
for 40 – 70% of effective travel	⩽ 2% of R_{total}
for 70 – 100% of effective travel	⩽ 8% of R_{total}
special law,	
for 0 – 40% of effective travel	⩽ 1,2% of R_{total}
for 40 – 60% of effective travel	⩽ 3% of R_{total}
for 60 – 100% of effective travel	⩽ 6% of R_{total}
Crackle voltage at maximum slider current of 1 mA, the slider being moved maximum 0,025 mm/s.	
R_n = 100 kΩ, linear law	⩽ 100 mV
R_n = 100 kΩ, special law,	
for 0 – 60% of effective travel	⩽ 100 mV
for 60 – 100% of effective travel	⩽ 150 mV
Change of preset voltage after vibration test (IEC 68, test Fc) and shock test (IEC 68, test Ea)	⩽ 0,1% of total voltage typ. 0,05% of total voltage

Measurement of the contact resistance

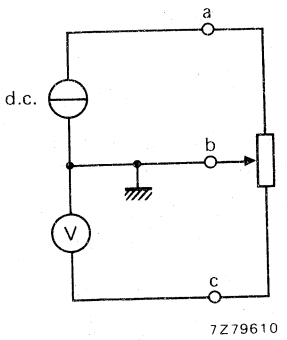


Fig. 2.

A d.c. current source which supplies a constant direct current (I) of e.g. 1 mA, is connected to pins a and b of the potentiometer. The d.c. voltage (V) resulting from the contact resistance (R_c) and the d.c. current is measured between pins b and c ($V = I.R_c$).

During the measurement the slider contact is moved with a constant speed of 1 mm/s. The input resistance of the d.c. voltmeter must be at least 10 MΩ.

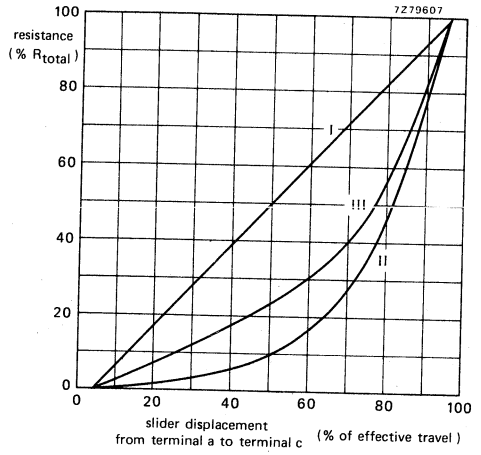


Fig. 3 Resistance as a function of slider displacement. Counter-clockwise knob rotation results in an increase of resistance between a and b (Fig. 1).

curve	resistance law	tolerance on resistance law	
		displacement	resistance
		% of effective travel	% of R_{total}
I	linear	between 36,5 and 38,5 between 61,5 and 63,5	33,5 - 41,5 58,5 - 66,5
II	logarithmic	between 36,5 and 38,5 between 61,5 and 63,5	3,5 - 8,5 12 - 26
III	special	between 36,5 and 38,5 between 61,5 and 63,5 between 86,5 and 88,5	14 - 22 28 - 38 60 - 75

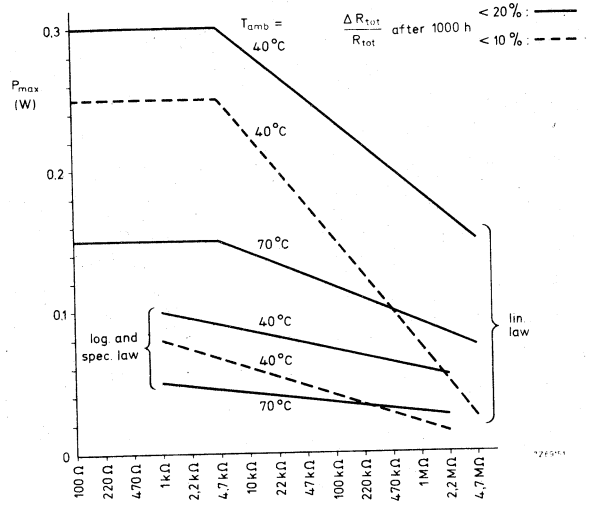


Fig. 4 Maximum permissible power dissipation.

Resistance change as a function of temperature; relative humidity 40 to 80% at 25 °C.

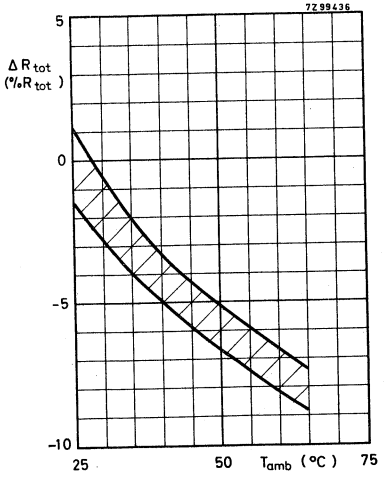


Fig. 5 R_n = 100 kΩ, linear law.

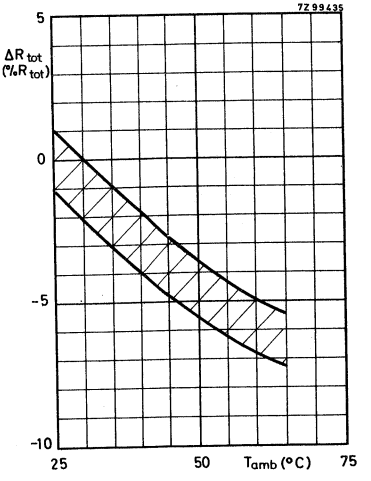


Fig. 6 R_n = 100 kΩ, special law.

Change of preset voltage as a function of temperature, $V_{a\text{-}b}$ being 30% of $V_{a\text{-}c}$; relative humidity 40 to 80% at 25 °C.

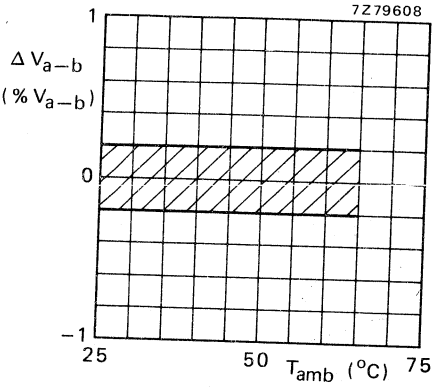


Fig. 7 R_n = 100 kΩ, linear law.

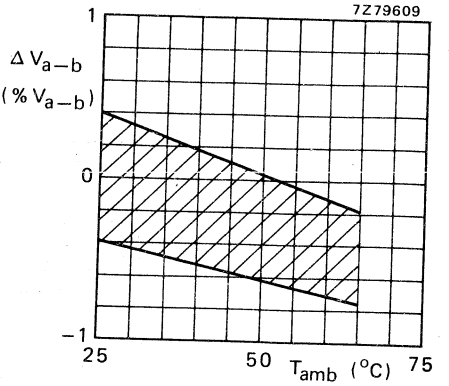


Fig. 8 R_n = 100 kΩ, special law.

MULTI-TURN CARBON PRESET POTENTIOMETERS

with bandswitch

This data should be read in conjunction with that multi-turn carbon preset potentiometers, types CMP10, CMP20, CMP40 (catalogue numbers 2322 413 ....., 2322 412 ..... and 2322 414 .....).

Type CMP/S. is basically identical to CMP ..., however, equipped with a 3-position bandswitch. The switch is designed for band switching in television or radio tuners and is of the "break before make" type. Two switch versions are available: /SK is equipped with a black knob, and /SL has a red lever.

MECHANICAL DATA

Type /SK, outline drawing

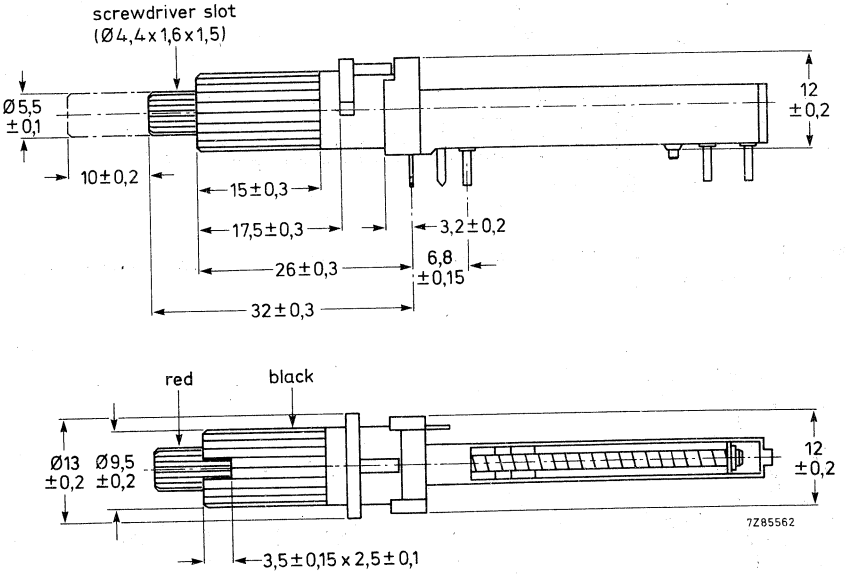


Fig. 1.

Operating torque		10 to 40 mNm
End stop torque		> 250 mNm
Switching angle		2 x 40 degrees
Climatic category		25/070/21
Life		> 1000 cycles
Shaft load		
radial push	max.	2,5 N
axial pull	max.	5 N
axial push	max.	5 N

Type /SL, outline drawing

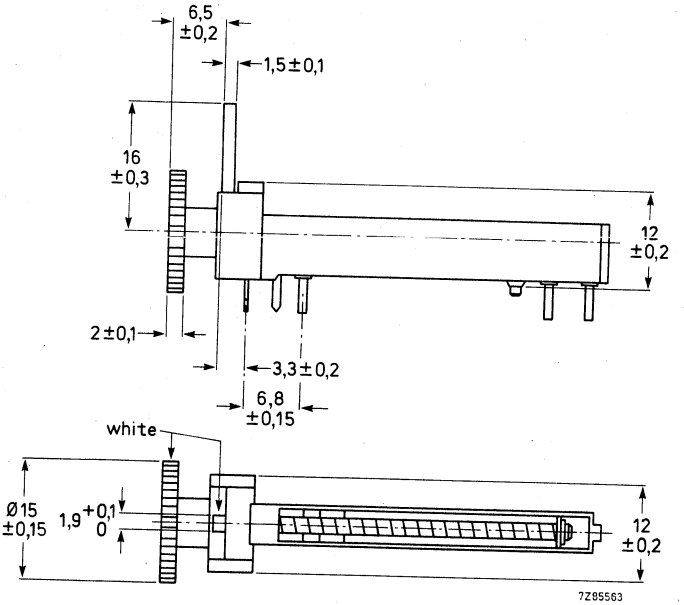


Fig. 2.

The potentiometers can be mounted on a printed wiring board with a piercing plan according to Fig. 3, viewed from the component side.

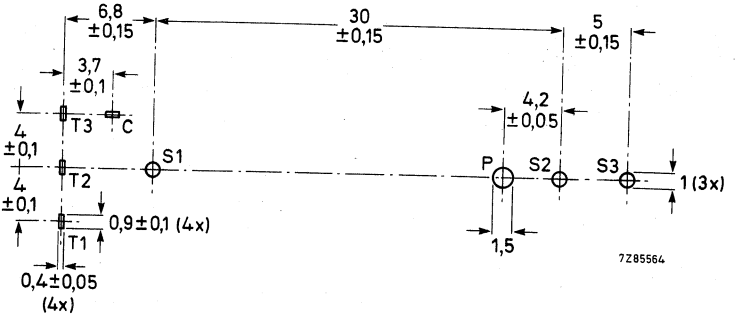


Fig. 3.

ELECTRICAL DATA of the switch

Rating (load applied)	35 V/20 mA
Function	1 section, 3 contacts
Contact resistance, max.	50 mΩ at a 5 mA

Catalogue number will be indicated on request.

10 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω – 4,7 MΩ
Maximum dissipation at 40 °C	0,1 W
Climatic category, IEC 68	25/070/21

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustment. They are particularly suitable for use in radio and television receivers.

DESCRIPTION

These potentiometers have a resistance element of a special carbon composition with a low temperature coefficient. The element is riveted to a base plate of resin bonded paper.
The potentiometers are provided with printing-wiring pins; pins a and c (see Figs 1, 3 and 5) are connected to the ends of the carbon track, pin b is connected to the slider. The slider, which is provided with a double contact, has a screwdriver slot or a plastic knob for adjustment.
This potentiometer series includes types for vertical and for horizontal mounting on printed-wiring boards.

Note: The potentiometers are supplied with the slider at 50% of the angle of rotation.

COMPOSITION OF THE CATALOGUE NUMBER

2322 410 . . . . .

0 = without knob
4 = with knob (Fig. 2; only for 2322 410 .50..)
6 = with knob (Figs 4 and 6; only for 2322 410 .11.. and 2322 410 .33..)

code for resistance value, see Table 1

11 = vertical mounting (Fig. 3)
33 = horizontal mounting (Fig. 5)
50 = vertical mounting (Fig. 1)

Note: catalogue number of knob (Fig. 2): 4322 047 00190 (only for 2322 410 .50..);
catalogue number of knob (Figs 4 and 6): 4322 047 27740 (only for 2322 410 .11.. and 2322 410 .33..).

MARKING

The potentiometers are marked with the nominal resistance value punched on the slider.

OUTLINES

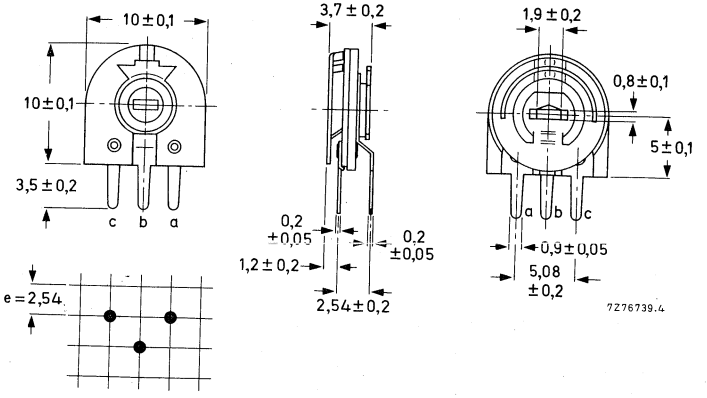


Fig.1 Potentiometer for vertical mounting 2322 410 050 . .

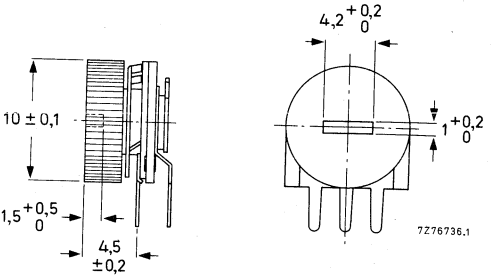


Fig.2 Potentiometer for vertical mounting with knob 2322 410 450 . .

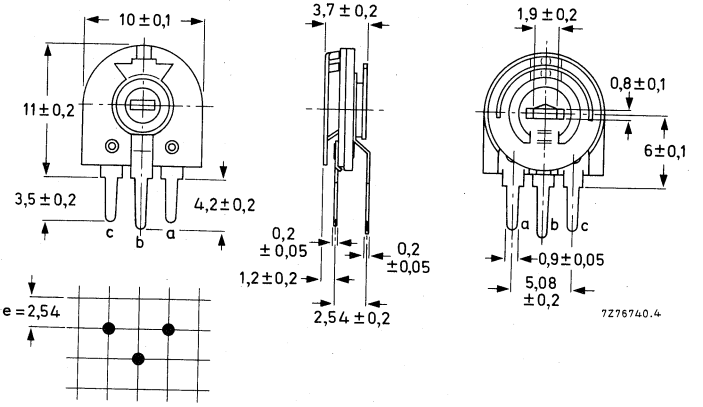


Fig.3 Potentiometer for vertical mounting 2322 410 011 . .

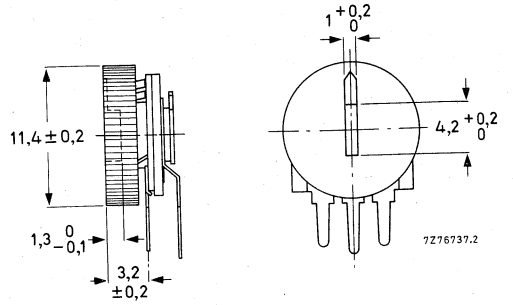


Fig. 4 Potentiometer for vertical mounting with knob 2322 410 611 . .

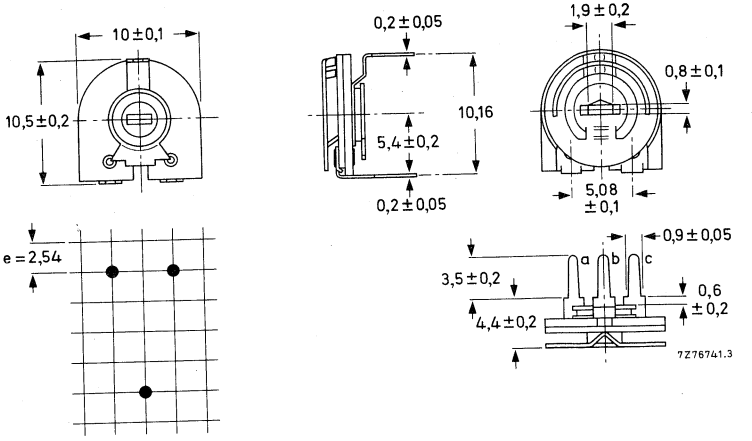


Fig. 5 Potentiometer for horizontal mounting 2322 410 033 . .

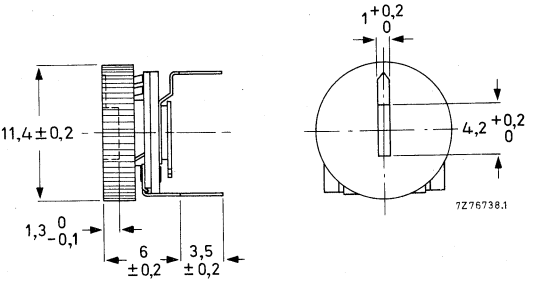


Fig. 6 Potentiometer for horizontal mounting with knob 2322 410 633 . .

TECHNICAL DATA

Unless otherwise specified all electrical values apply at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

Table 1

nom. resistance R_n	max. voltage (V) at 40 °C	max. terminal resistance Ω	limiting slider current (mA) at 40 °C	code in catalogue number
47 Ω	2,2	10	46	91
100 Ω	3,2	10	32	51
220 Ω	4,7	10	21	52
330 Ω	5,7	10	17	69
470 Ω	6,9	10	15	53
1 kΩ	10	20	10	54
2,2 kΩ	14,8	40	6,7	55
4,7 kΩ	21,7	100	4,6	56
10 kΩ	32	200	3,2	57
22 kΩ	47	400	2,1	58
47 kΩ	69	1 000	1,5	59
100 kΩ	100	2 000	1,0	61
220 kΩ	148	4 000	0,7	62
470 kΩ	150	10 000	0,32	63
1 MΩ	150	20 000	0,15	64
2,2 MΩ	150	40 000	0,068	65
4,7 MΩ	150	100 000	0,032	66

Tolerance on the nominal resistance	± 20%
Resistance law	linear
Maximum dissipation (P_{max}),	
at 40 °C	0,1 W
at 70 °C	0,05 W
Maximum voltage	$\sqrt{P_{max} R_n}$; maximum 150 V (see table above)
Ambient temperature range	−25 to + 70 °C
Climatic category, IEC 68	25/070/21
Temperature coefficient	−500 to + 300 . 10^{-6}/K
Operating torque	3,5 to 25 mNm
Maximum end stop torque	50 mNm
Effective angle of rotation	200 ± 10°
Mechanical angle of rotation	260 ± 5°
Life	50 cycles
Mass	
potentiometer without knob	0,40 g
potentiometer with knob	0,60 g

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers; part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board. When drying is called for, procedure 1 of IEC 393-1, sub. 5.2 is used (24 ± 4 h, sub. 55 ± 2 °C, R.H. ⩽ 20%). When the contact resistance variation (CRV) is measured, the slider is rotated in both directions over 90% of the effective resistance.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	Ta	Solderability	solder bath: 230° ± 5 °C, 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration 40 g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 12\%$
6.24	Ec	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 10 g, 3 directions, 2 h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leqslant 0{,}3\%$
6.13	–	Temperature characteristics of resistance	temp. cycle: +20 °C; −25 °C; +20 °C; +70 °C; +20 °C	$-500 < TC < +300 \cdot 10^{-6}/K$
6.26	–	Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ operating torque ⩽ 30 mNm
6.26.2	Ba	Dry heat	16 h at 70 ± 2 °C	
6.26.3	Db	Damp heat acc. 1st cycle	24 h at 55 ± 2 °C 95 – 100% R.H.	
6.26.4	Aa	Cold	2 h at −55 ± 3 °C	
6.26.6	Db	Damp heat, remaining cycle	24 h at 55 ± 2 °C 95 – 100% R.H.	
6.30	–	Electrical endurance	T_{amb}: 70 °C, 1000 h, cycle (1,5 h on and 0,5 h off, b at 0,67 a – c) Load: 0,05 W between a and c	CRV < 2% of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$
			Load: 0,033 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.28	–	Mechanical endurance	50 cycles, 4 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ for $R_n \leqslant 100\ k\Omega$ $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ for $R_n > 100\ k\Omega$ CRV $< 0{,}5\%$ of R_{ac}
6.27	C	Damp heat steady state	slider at 0,67 a - c load via a - c recovery 24 h 22 ± 1 °C, 50% R.H. ± 5%	CRV $< 0{,}5\%$ of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$

14 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω – 4,7 MΩ
Maximum dissipation at 40 °C	0,3 W
Climatic category, IEC 68	55/100/10
Dimensions based upon spec.	DIN 44150

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in radio and television receivers.

DESCRIPTION

These preset potentiometers comprise a carbon track, which is riveted on to a base plate of resin-bonded paper. They are provided with snap-in printed-wiring pins, which hold them firmly in place on the board before soldering. They are also available with straight printed-wiring pins.

The pins a and c (see Figs 1a, 2a, 3 and 4) are connected to the ends of the carbon track; pin b is connected to the slider. The slider has a central screwdriver slot, a plastic knob or a wheel for adjustment. This potentiometer series includes two types: one for vertical and one for horizontal mounting on printed-wiring boards.

COMPOSITION OF THE CATALOGUE NUMBER

2322 409 . . . .

0 = without knob
1 = with knob at the side of the base plate
2 = with knob at the side of the carbon track
4 = with adjustment wheel at the side of the carbon track

02 = straight pins, vertical mounting
13 = straight pins, horizontal mounting
22 = snap-in pins, vertical mounting
33 = snap-in pins horizontal mounting

code for resistance value,	
91	47 Ω
51	100 Ω
52	220 Ω
69	330 Ω
53	470 Ω
54	1 kΩ
55	2,2 kΩ
56	4,7 kΩ
57	10 kΩ
58	22 kΩ
59	47 kΩ
61	100 kΩ
62	220 kΩ
63	470 kΩ
64	1 MΩ
65	2,2 MΩ
66	4,7 MΩ

MARKING

The potentiometers are marked with the rated resistance value, by letter punches on the wiper or knob.

Outlines

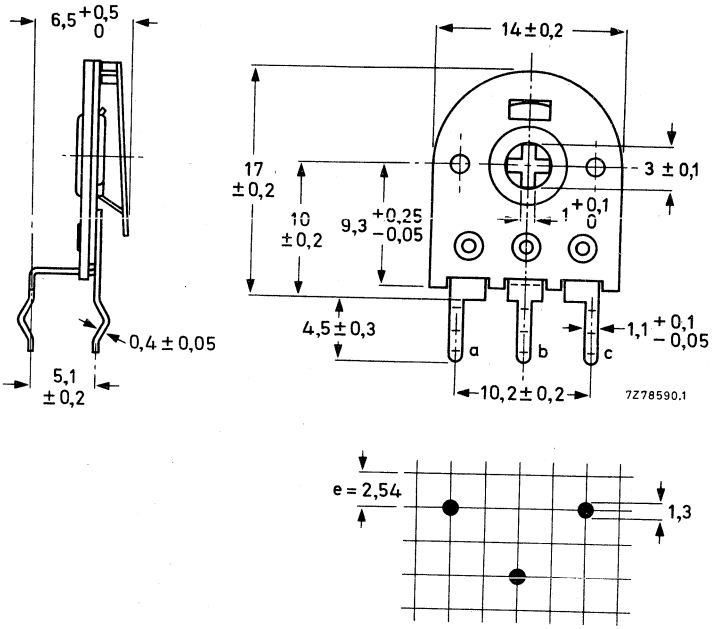


Fig.1a Potentiometer for vertical mounting, with snap-in printed-wiring pins, 2322 409 022.

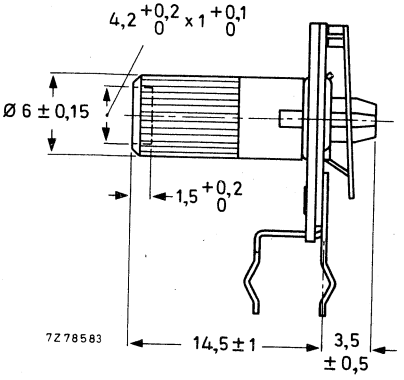


Fig. 1b Potentiometer with knob on the base plate side, 2322 409 122. .

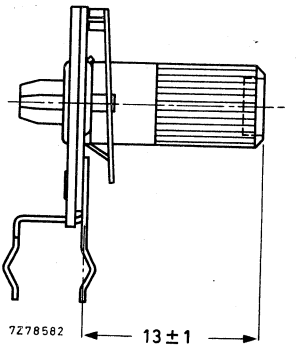


Fig. 1c Potentiometer with knob on the carbon track side, 2322 409 222. .

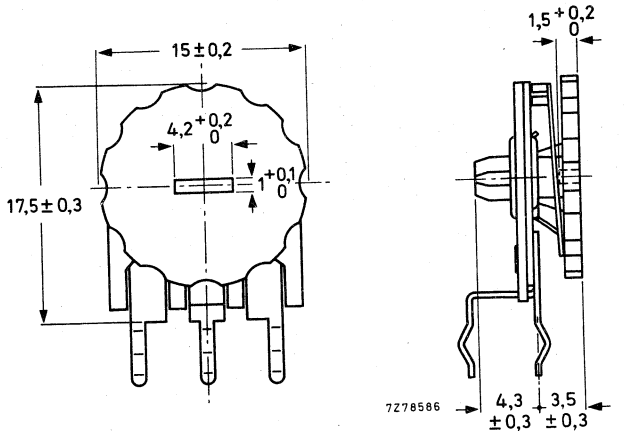


Fig.1d Potentiometer with adjustment wheel on the carbon track side, 2322 409 422. .

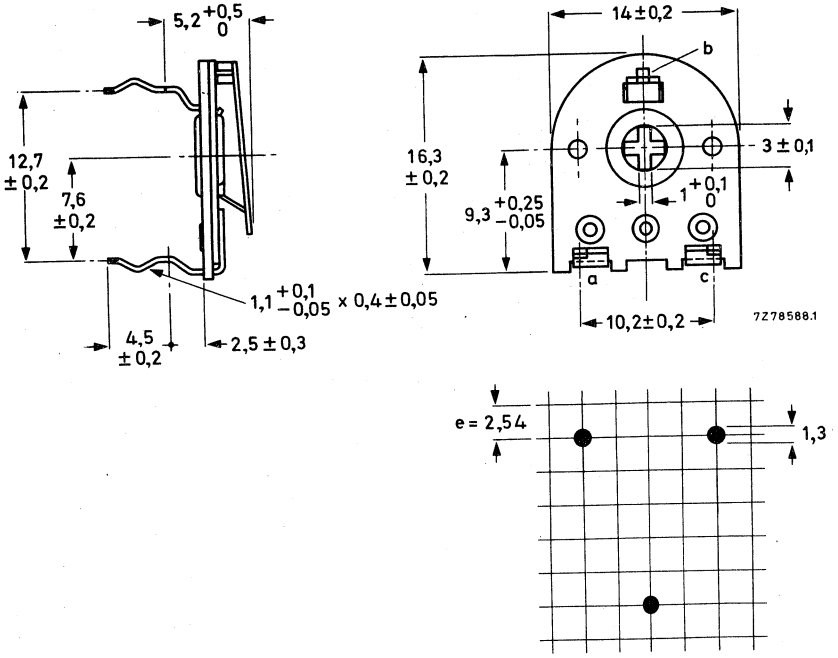


Fig.2a Potentiometer for horizontal mounting, with snap-in printed-wiring pins, 2322 409 033..

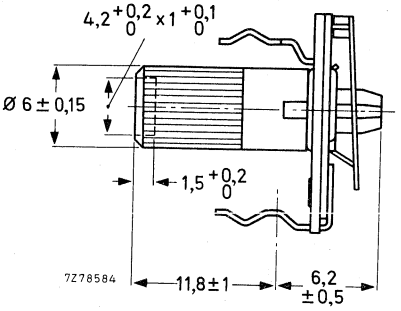


Fig. 2b Potentiometer with knob on the base plate side, 2322 409 133. .

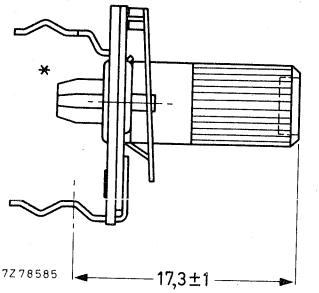


Fig. 2c Potentiometer with knob on the carbon track side, 2322 409 233. .

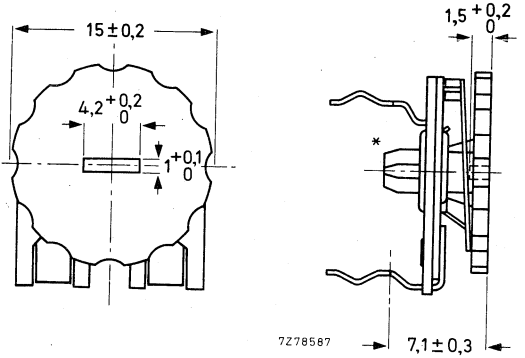
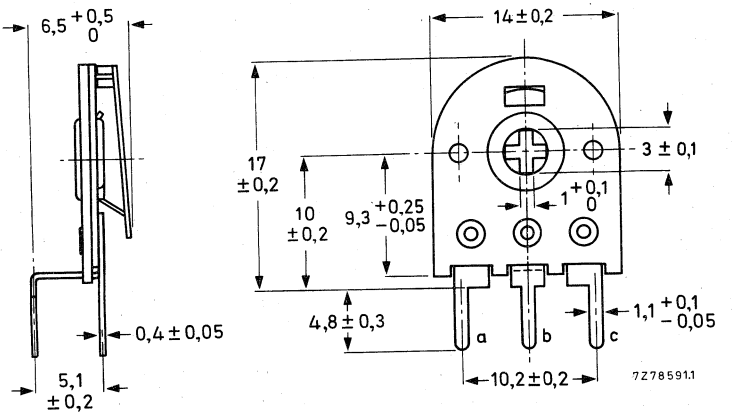


Fig. 2d Potentiometer with adjustment wheel on the carbon track side, 2322 409 433. .

* Required hole in printed-wiring board: ϕ4 + 0,2 mm.



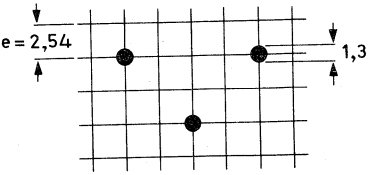
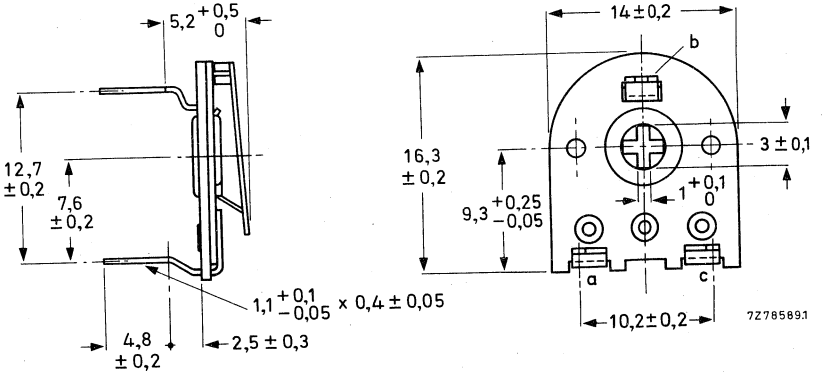


Fig.3 Potentiometer for vertical mounting, with straight printed-wiring pins, 2322 409 002..



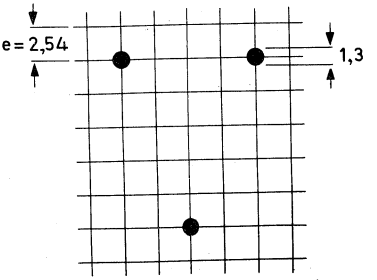


Fig.4 Potentiometer for horizontal mounting, with straight printed-wiring pins, 2322 409 013..

Note

For dimensions of knob or wheel versions see relevant drawing of snap-in-pin counterpart.

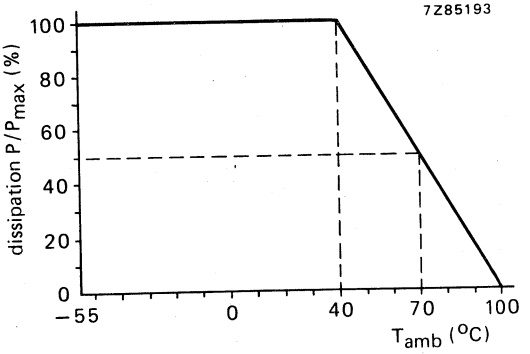
TECHNICAL DATA

Mass, per 100		
without knob		72 g
with knob		118 g
Resistance range (E3-series)		47 Ω to 4,7 MΩ
Standard tolerance		± 20%
Resistance law		linear, see Fig. 6
Rated dissipation		
at 70 °C (P_{max})		0,15 W, see Fig. 5
at 40 °C		0,3 W
Limiting element voltage		500 V (d.c.)
Limiting slider current		$\sqrt{\frac{P_{max}}{R_N}}$
Minimum effective resistance		⩽ 2% of R_N
Rotational noise limits (contact resistance variation)		⩽ 2% of R_{ac}
Temperature coefficient in the range −55 °C to + 100 °C		−500 to + 300 · 10^{-6}/K
Starting torque		⩽ 25 mNm
Operating torque		3,5 to 25 mNm
Permissible end-stop torque		max. 100 mNm
Total mechanical angle of rotation		230 ± 5°
→ Effective angle of rotation		210 ± 10°
Settability		0,1% within 10 s
Terminal resistance		⩽ 100 mΩ
Climatic category according to IEC 68-2		55/100/10
Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%
Damp heat, steady state, 10 days max.	$R_N \leqslant 100$ K	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 15%
	$R_N > 100$ K	$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 20%
Mechanical endurance (50 cycles)		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%
Electrical endurance (1000 h at 70 °C, cyclic)		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 10%
Resistance to soldering heat		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 2%
Bump		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 2%
Vibration		$\frac{\Delta R_{ac}}{R_{ac}}$ ⩽ 2%
		$\frac{\Delta V_{ab}}{V_{ab}}$ ⩽ 0,5%

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 100 °C. The dissipation below 40 °C is the rated dissipation.

100% = 0,3 W



For $\Delta R_{ac} \leqslant 10\%$

Fig. 5 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are linear.

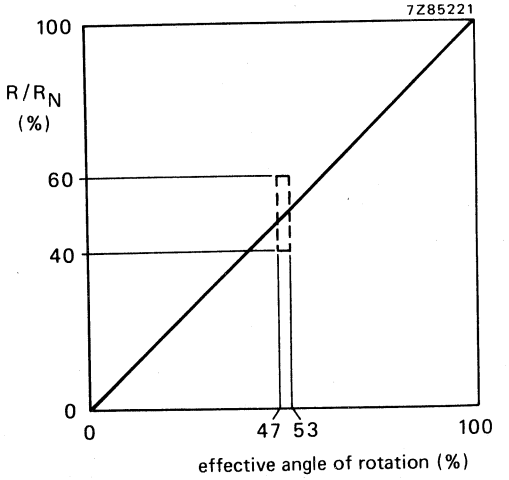


Fig. 6 Linear resistance law.

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393-1 (potentiometers; part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board. When drying is called for, procedure I of IEC 393-1, sub. 5,2 is used (24 ± 4 h, 55 ± 2 °C, R.H. ⩽ 20%). When the contact resistance variation (CRV) is measured, the slider is rotated in both directions over 90% of the effective resistance.

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.22.3	T_a	Solderability	solder bath: 235° ± 5 °C, 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C, 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration: 390 m/s² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.24	Ec	Vibration	frequency: 10 to 500 Hz amplitude: 0,75 mm or 98 m/s², 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ab}} \leqslant 0{,}1\%$
6.13	–	Temperature characteristics of resistance	temp. cycle: +20 °C; −55 °C; +20 °C; +100 °C; +20 °C	$-300 < TC < +300 \cdot 10^{-6}/K$
6.26 6.26.2 6.26.3 6.26.4 6.26.6	– Ba Db Aa Db	Climatic sequence Dry heat Damp heat accel. 1st cycle Cold Damp heat, remaining cycle	 16 h at 100 °C 24 h at 55 °C 95 - 100% R.H. 2 h at −55 °C 24 h at 55 °C 95 - 100% R.H.	 $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ operating torque ⩽ 30 mNm
6.30	–	Electrical endurance	T_{amb}: 70 °C, 1000 h, cyclic (1,5 h on and 0,5 h off, b at 0,67 a - c) Load: 0,15 W between a and c Load: 0,1 W between a and b	CRV < 1% of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 10\%$

IEC 393-1 clause	IEC 68-2 test method	test	procedure	typical result
6.28	—	Mechanical endurance	50 cycles, 5 - 10 cycles/min, no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ CRV $< 0{,}5\%$ of R_{ac}
6.27	C	Damp heat steady state	slider at 0,67 a - c load via a - c recovery 24 h 22 ± 1 °C, 50% R.H. ± 5% (CECC 41 000 clause 4.29)	CRV $< 0{,}5\%$ of R_{ac} $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$

18 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	100 Ω – 4,7 MΩ
Maximum dissipation at 25 °C	0,25 W

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in radio and television receivers.

DESCRIPTION

These preset potentiometers comprise a carbon track, which is riveted on to a base plate of resin-bonded paper. They are provided with tin-plated printed-wiring pins. The pins S1 and S3 (see figures on following pages) are connected to the ends of the carbon track; S2 is connected to the slider. The slider has a central screwdriver slot, a plastic knob or a wheel for adjustment.

COMPOSITION OF THE CATALOGUE NUMBER

2322 411 . . . .

- 0 = without knob
- 1 = with knob at the side of the base plate
- 2 = with knob at the side of the carbon track
- 3 = with adjustment wheel at the side of the base plate (only for versions 022 and 073)
- 4 = with adjustment wheel at the side of the carbon track

- code for resistance value, see table
- 22 = with pins for vertical mounting (Fig.1)
- 33 = with pins for horizontal mounting (Fig.5)
- 72 = with pins for vertical mounting (according to DIN 44150, Fig.3)
- 73 = with pins for vertical mounting (Fig.4)
- 83 = with pins for horizontal mounting (according to DIN 44150, Fig.6)
- 84 = with pins for horizontal mounting (according to DIN 44151, Fig.7)

Catalogue number of adjustment wheel: 4322 047 08230
Catalogue number of adjustment knob : 4322 047 08280.

MARKING

Nominal resistance and production code in ink on the base plate.

Outlines

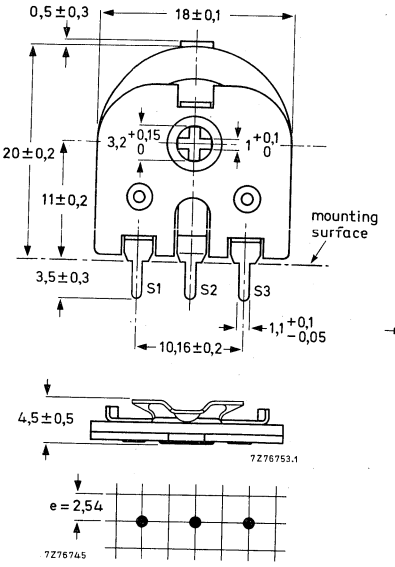


Fig. 1 Potentiometer 2322 411 022. .

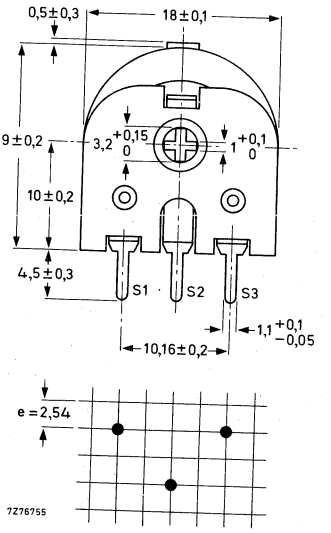


Fig. 2 Potentiometer 2322 411 072. .

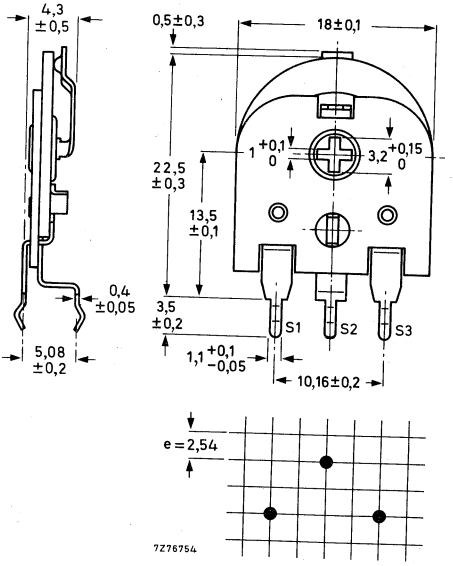


Fig. 3 Potentiometer 2322 411 073 . .

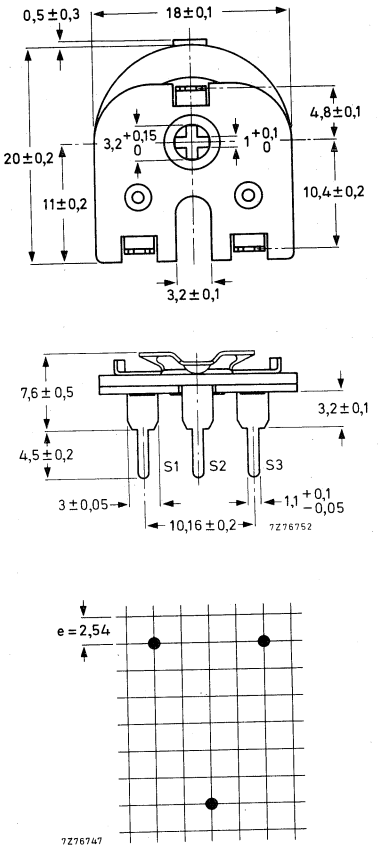


Fig. 4 Potentiometer 2322 411 033. .

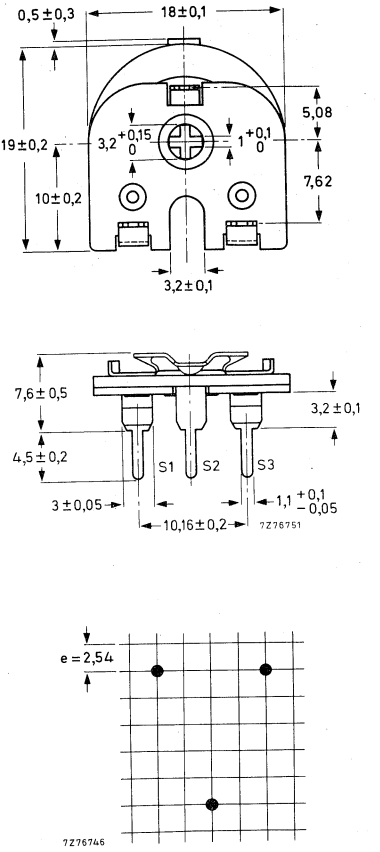


Fig. 5 Potentiometer 2322 411 083. .

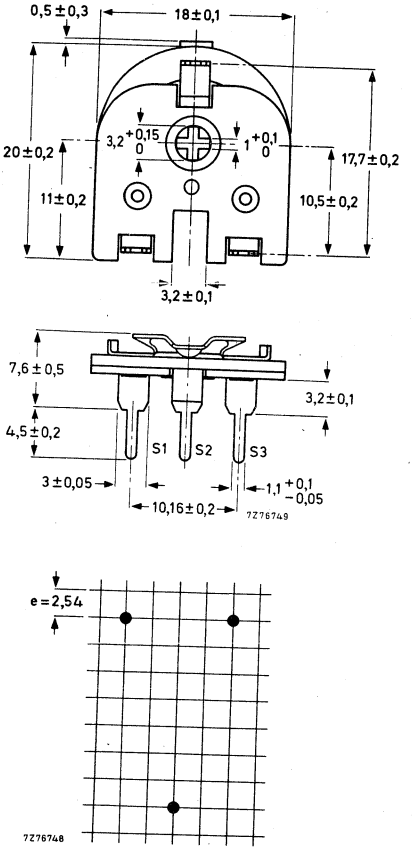


Fig. 6 Potentiometer 2322 411 084. .

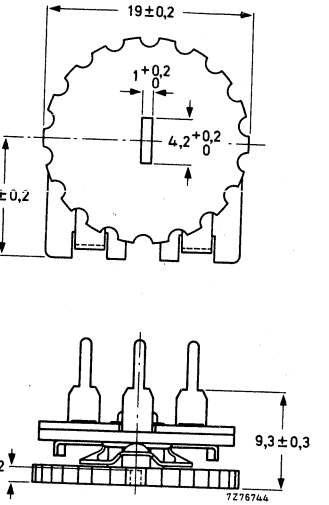


Fig. 7 Potentiometer 2322 411 433. . (adjustment wheel on the carbon track side).

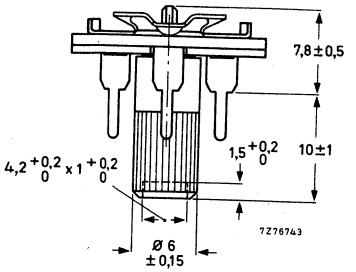


Fig. 8 Potentiometer 2322 411 133 . . (adjustment knob on the base plate side).

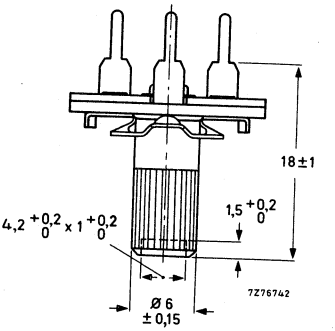


Fig. 9 Potentiometer 2322 411 233 . . (adjustment knob on the carbon track side).

TECHNICAL DATA

nom. resistance R_n	max. terminal resistance Ω	V_{max} (d.c. or r.m.s.) at T_{amb} = 40 °C V	limiting slider current mA	code in catalogue number
100 Ω	10	5	32	51
220 Ω	10	7	22	52
330 Ω	10	9	18	69
470 Ω	10	11	14	53
1 kΩ	25	16	10	54
2,2 kΩ	25	22	7	55
4,7 kΩ	100	35	4,5	56
10 kΩ	200	50	3,2	57
22 kΩ	400	70	2,2	58
47 kΩ	1 000	110	1,4	59
100 kΩ	2 000	160	1,0	61
220 kΩ	4 000	220	0,7	62
470 kΩ	10 000	370	0,45	63
1 MΩ	20 000	500	0,32	64
2,2 MΩ	40 000	500	0,22	65
4,7 MΩ	100 000	500	0,14	66

Tolerance on the nominal resistance	±20%
Resistance law	linear
Maximum dissipation at 25 °C at 70 °C	 0,25 W 0,15 W
Limiting voltage	500 V (d.c.) 500 V (r.m.s.)
Ambient temperature range	−25 to +70 °C
Resistance change after humidity test (21 days, T_{amb} = 40 °C, R.H. = 90 - 95%) after recovery of 1 h * after recovery of 24 h *	 < 20% < 10%
Operating torque	5 to 35 mNm
Maximum end stop torque	100 mNm
Effective angle of rotation	200 ± 10°
Mechanical angle of rotation	215–225°
Temperature coefficient	−500 to +300 . 10^{-6}/K

* Preconditioning (min 48 h) and recovery at 23 ± 1 °C, R.H. = 50 ± 2%.

ENCLOSED 10 mm CARBON PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E3-series), linear law	47 Ω to 4,7 MΩ
Maximum dissipation	
at 40 °C	0,1 W
at 70 °C	0,05 W
Temperature coefficient	± 300 . 10^{-6}/K
Climatic category, IEC 68–2	25/85/10

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustment. The completely enclosed construction renders these potentiometers suitable for application in poorly conditioned environments.

DESCRIPTION

These preset potentiometers comprise a carbon resistive element on a phenolic paper base. The actuating device is a plastic rotor or a metal wiper. Adjustment is by means of cross or hexagonal recesses. The overall width of 9,6 mm allows for high density use with air-gap isolation on a 2,54 mm grid; either horizontal or vertical mounting. The brown glass-filled synthetic resin housing is fire resistant. The potentiometers, which are manufactured fully automatically, offer stable, high quality performance and can be mounted by automatic insertion machines.

MECHANICAL DATA

Dimensions in mm

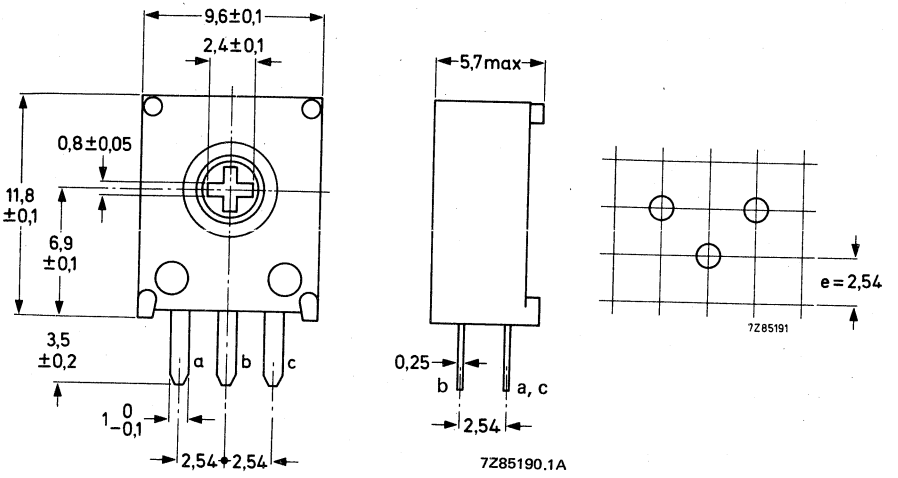


Fig. 1 Vertical mounting, version with cross-shaped recess (non-insulated hot wiper, b).

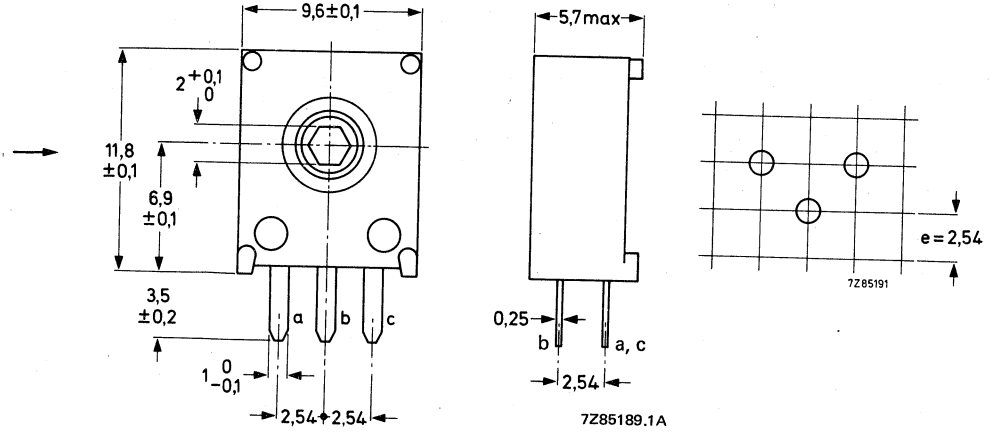


Fig. 2 Vertical mounting, version with hexagonal recess (insulated cold wiper, b).

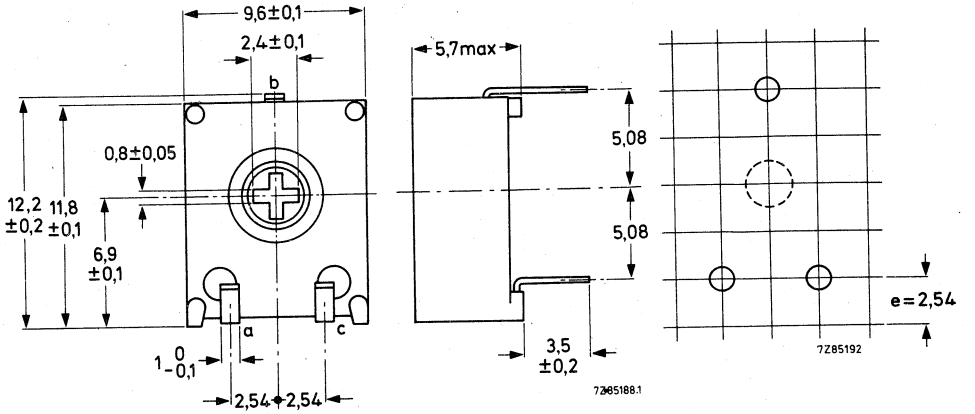


Fig. 3 Horizontal mounting, version with cross-shaped recess (non-insulated hot wiper, b).

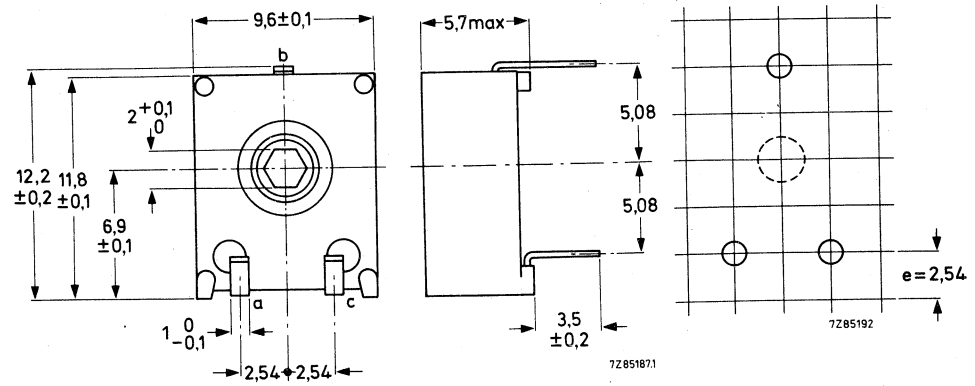


Fig. 4 Horizontal mounting, version with hexagonal recess (insulated cold wiper, b).

DEVELOPMENT SAMPLE DATA

TECHNICAL DATA

Mass		~ 1,5 g
Resistance range (E3-series)		47 Ω to 4,7 MΩ
Standard tolerance		± 20% and ± 10%
Resistance law		linear, see Fig. 6
Rated dissipation at 40 °C (P_{max})		0,1 W, see Fig. 5
Limiting element voltage		150 V (d.c.)
Limiting slider current		$\sqrt{\frac{P_{max}}{R_N}}$
Minimum effective resistance		⩽ 2% of R_N or 10 Ω, whichever is greater
Rotational noise limits (contact resistance variation)		⩽ 1,0% of R_N
Temperature coefficient in the range −25 °C to +85 °C		± 300 . 10^{-6}/K
Operating torque		0,5 to 10 mNm
Permissible end-stop torque		max. 50 mNm
Total mechanical angle of rotation		300 ± 5°
Effective angle of rotation		295 ± 5°
Settability		0,2% within 10 s
Climatic category according to IEC 68–2		25/85/10
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 5%
Damp heat, steady state, with or without load, between a and c, 10 days	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 10%
Mechanical endurance (100 cycles)	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 5%
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 5%
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 0,5%
Bump	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
Vibration	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
	$\frac{\Delta V_{ab}}{V_{ac}}$	⩽ 0,5%

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 100 °C. The dissipation below 40 °C is the rated dissipation.

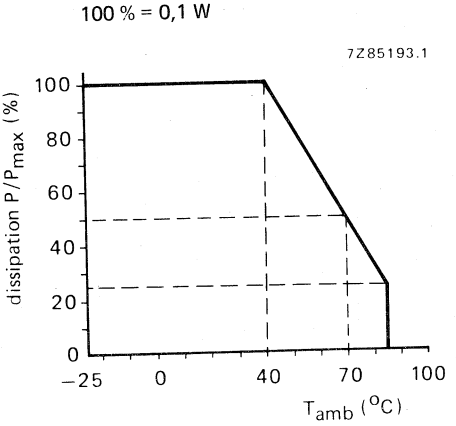


Fig. 5 Dissipation as a function of ambient temperature.

RESISTANCE

Potentiometers covered by this specification are linear.

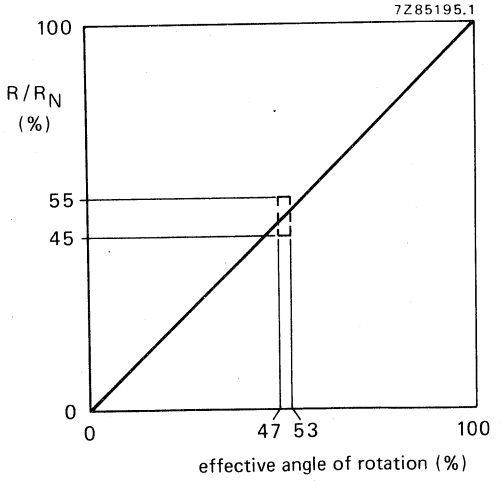


Fig. 6 Linear resistance law.

MARKING

The potentiometers are marked with the rated resistance, according to IEC 62, e.g. 220 Ω = 220 R; 10 kΩ = 10 k; 1 MΩ = 1 MO.

The package is marked with:
- catalogue number,
- date of production,
- quantity.

COMPOSITION OF THE CATALOGUE NUMBER

2322 483 A B C D E

0 = vertical, cross-shaped recess
1 = vertical, hexagonal recess
5 = horizontal, cross-shaped recess
6 = horizontal, hexagonal recess

code for tolerance:
0 = ± 20%
1 = ± 10%

resistance code: first two significant figures of the resistance followed by:
9 for R of 47 Ω
1 for R of 100 to 470 Ω
2 for R of 1 kΩ to 4,7 kΩ
3 for R of 10 kΩ to 47 kΩ
4 for R of 100 kΩ to 470 kΩ
5 for R of 1 MΩ to 4,7 MΩ

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393–1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounted by their terminations on a printed wiring board.

When drying is called for procedure I of IEC 393–1, sub 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the slider is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

DEVELOPMENT SAMPLE DATA

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 230 ± 10 °C,	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C, 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.25	Eb	Bump	acceleration: 390 m/s² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 98 m/s², 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}3\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; −25 °C; + 20 °C; + 70 °C + 20 °C	$-300 < TC < +300 \cdot 10^{-6}/K$
6.26	–	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 85 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$
6.26.3	D	Damp heat, accel. 1st cycle	24 h at 55 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at −25 °C	
6.26.6	D	Damp heat remaining cycle	24 h at 55 °C 95 - 100% R.H.	
(6.30)	–	Electrical endurance	T_{amb}: 70 °C, 1000 h cycle (1,5 h on and 0,5 h off, b at 0,67 a - c) Load: 0,05 W between a and c	CRV < 2% of R_N $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$
			Load: 0,033 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.29	–	Mechanical endurance	100 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ CRV < 1,0% of R_N
(6.27)	C	Damp heat steady state	wiper at 0,67 a - c *no load;* 21 days; recovery 24 h, 22 ± 1 °C, 50% R.H. ± 5%	CRV < 1,0% of R_N $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0,2\%$
(6.27)	C	Damp heat steady state	*with load* between a and c, 10 days; recovery 24 h, 22 °C ± 1 °C, 50% R.H. ± 5%	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 10\%$

13 mm CARBON CONTROL POTENTIOMETERS

QUICK REFERENCE DATA

Resistance law	linear and logarithmic
Resistance values	4,7, 10 and 22 kΩ

GENERAL

These potentiometers are for use in miniaturized electronic equipment such as dictaphones, small radio sets, etc. On account of their application a special construction has been used, which makes mounting of a control knob superfluous.

The potentiometers can be fixed on a chassis with the supplied mounting nut, catalogue number 4322 047 09530.

Outlines

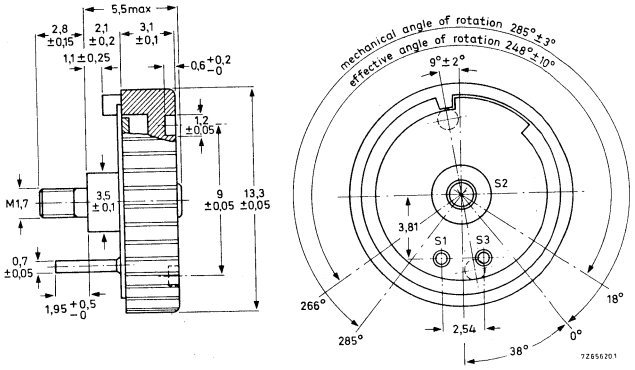


Fig. 1 S_1, S_2, S_3 = potentiometer terminals (S_1 and S_3 are connected to the ends of the carbon track; S_2 is connected to the slider contact.

TECHNICAL DATA

Nominal resistance	4,7, 10 and 22 kΩ
Tolerance on the nominal resistance	± 20%
Resistance law	linear and logarithmic
Contact resistance between carbon track and slider	
linear law	⩽ 5% of R_n
logarithmic law	⩽ 10% of R_n
Terminal resistance	
linear law	⩽ 1% of R_n
logarithmic law	⩽ 0,1% of R_n
Insulation resistance	> 1 MΩ
Maximum attenuation	⩾ 60 dB
Maximum voltage over the resistance element	10 V (d.c.)
Current through slider	⩽ 1 mA
Test voltage for 1 min	100 V, 50 Hz
Working temperature range	−10 to + 70 °C
Effective angle of rotation	248 ± 10°
Mechanical angle of rotation	285 ± 3°
Operating torque	2 to 10 mNm
Maximum permissible torque with slider at end stop	50 mNm
Life	in excess of 15 000 cycles

COMPOSITION OF THE CATALOGUE NUMBER

2322 440 100 . .

06 = 4,7 kΩ 07 = 10 kΩ 08 = 22 kΩ	linear law
26 = 4,7 kΩ 27 = 10 kΩ 28 = 22 kΩ	logarithmic law

16 mm CARBON CONTROL POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range	
linear law	220 Ω – 4,7 MΩ
logarithmic law	1 kΩ – 2,2 MΩ
Maximum dissipation at 40 °C	
linear law	0,1 W
logarithmic law	0,05 W
Climatic category (IEC 68)	10/070/21

DESCRIPTION

The CP16 carbon control potentiometer series includes two types:

– single potentiometers, for general purposes,
– tandem potentiometers, for stereophonic purposes.

The single potentiometers comprise a carbon track, which is fitted on to a base plate of resin-bonded paper and housed in a metal case. The terminals a and c (see Types) are connected to the ends of the carbon track; terminal b is connected via a contact ring to the slider contact. The potentiometers can be supplied with a tap (d) at 46% (single) or 50% (tandem) of the total mechanical angle of rotation. The potentiometers are provided with plastic or metal spindles.

The tandem potentiometers are composed of two carbon tracks, on base plates of resin-bonded paper, in one housing. The base plates are placed in such a way that the tracks are opposite each other.

The single potentiometers can be delivered without switch or with a rotary switch; the tandem potentiometers are only supplied without switch. Both types are available with different connecting terminals, mounting facilities and spindles, see below.

Types

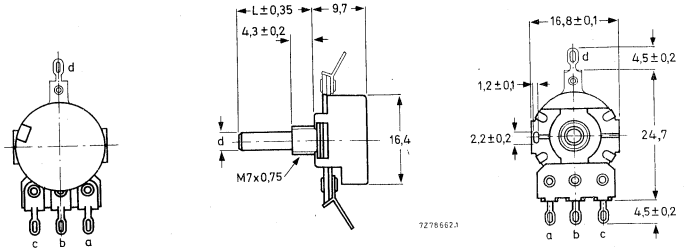


Fig. 1 Single potentiometer with mounting bushing. For dimensions d and L, see Spindles.

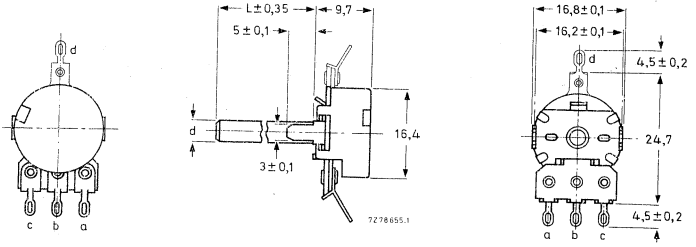


Fig. 2
Single potentiometer with twist tags. For dimensions d and L, see Spindles.

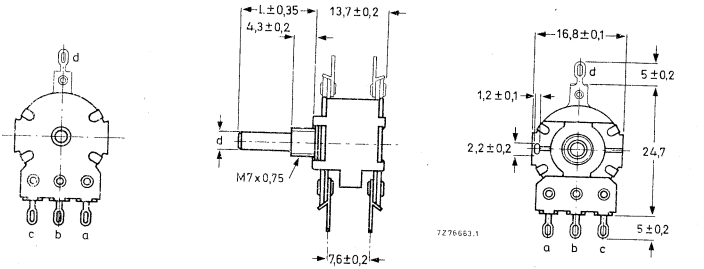


Fig. 3
Tandem potentiometer. For dimensions d and L, see Spindles.

Switches

Single-pole, single-throw, rotary switch (s.p.s.t.).

Fig. 4a Circuit in off-position of spindle (spindle turned fully counter-clockwise).

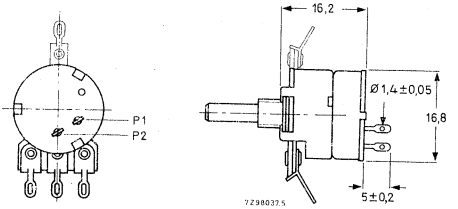


Fig. 4b Single potentiometer with s.p.s.t. rotary switch (spring actuated).

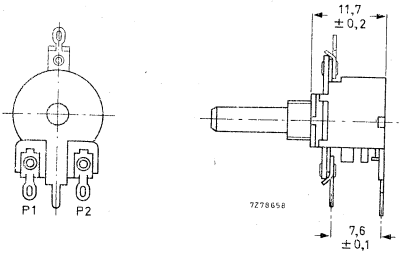


Fig. 4c Single potentiometer with s.p.s.t. rotary switch (direct operating).

Connecting terminals

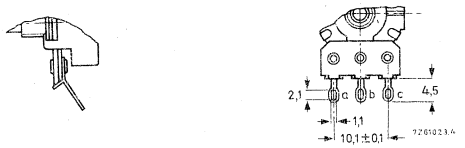


Fig. 5 Solder tags.

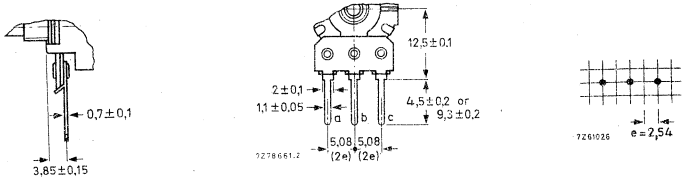


Fig. 6 Long or short printed-wiring pins (single potentiometer).

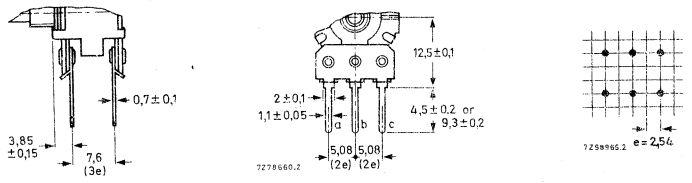


Fig. 7 Long or short printed-wiring pins (tandem potentiometer).

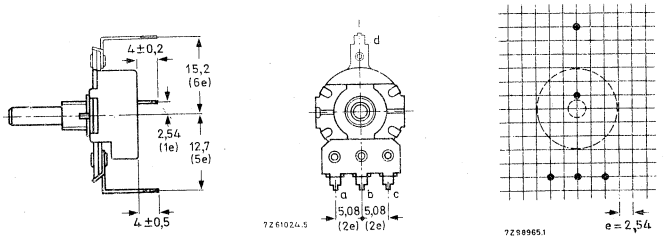
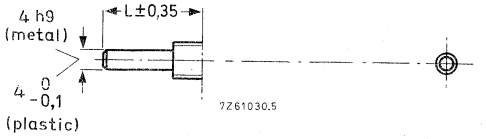
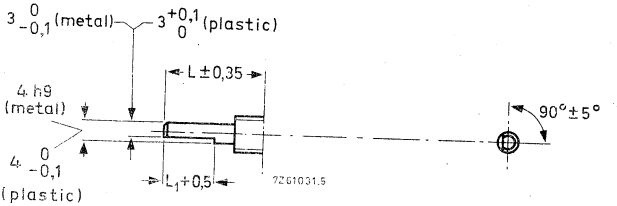
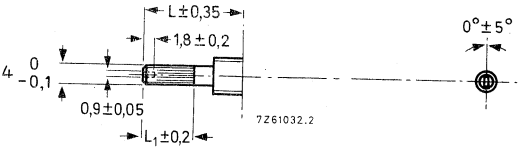
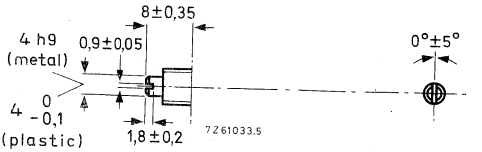
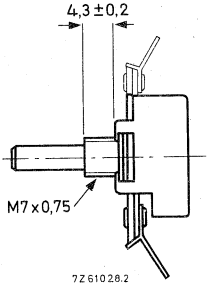
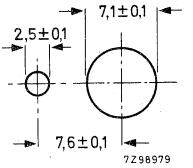
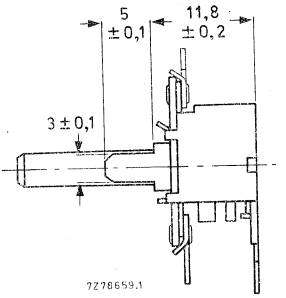
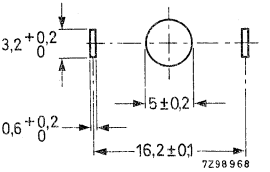


Fig. 8 Printed-wiring pins, bent backwards.

Spindles

type	off position	L mm	L_1 mm	material
		10 12 15 17 19 20 22 24 25 28 30		metal or plastic
		10 15 20 20	3,5 8,5 8,5 13,5	metal or plastic
		10 15 20	5 9 9	plastic
				metal or plastic

Mounting facilities

		required mounting holes in chassis	fixing of potentiometer
mounting bushing M7 x 0,75			with supplied mounting nut;* max. torque for tightening = 1 Nm; min. thickness of chassis = 1 mm
twist tags			by twisting the tags

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

* Catalogue number of mounting nut: 4322 047 00370.

TECHNICAL DATA

Unless otherwise specified, all values have been determined at an ambient temperature of 15 to 35 °C, at atmospheric pressure of 96 to 106 kPa and a relative humidity of 45 to 75%.
For measuring methods, see IEC publications 190 and 68. For the terms used, the "Glossary of terms" should be consulted.

nominal resistance R_n*	resistance law according to Figs 9 and 10	max. voltage at 40 °C V	max. terminal resistance	max. attenuation dB	max. contact resistance % R_n	limiting slider current at 40 °C mA
220 Ω	a	4,7	10 Ω	–	4	21
470 Ω	a	6,8	10 Ω	–	4	14,5
1 kΩ	a	10	25 Ω	–	4	10
2,2 kΩ	a	14	25 Ω	–	4	7
4,7 kΩ	a	22	25 Ω	–	4	5
10 kΩ	a	31	35 Ω	–	4	3,2
22 kΩ	a	45	35 Ω	–	4	2,2
47 kΩ	a	70	35 Ω	–	4	1,5
100 kΩ	a	100	100 Ω	–	4	1,0
220 kΩ	a	140	125 Ω	–	4	0,7
470 kΩ	a	220	250 Ω	–	4	0,5
1 MΩ	a	310	1 kΩ	–	4	0,32
2,2 MΩ	a	460	2 kΩ	–	4	0,22
4,7 MΩ	a	500	5 kΩ	–	4	0,14
1 kΩ	b	7	5 Ω	50	6	7
2,2 kΩ	b	10	5 Ω	50	6	5
4,7 kΩ	b	15	5 Ω	60	6	3,2
10 kΩ	b	22	10 Ω	60	6	2,2
22 kΩ	b	31	20 Ω	60	6	1,5
47 kΩ	b	50	35 Ω ▲	60 ▲	6	1,0
100 kΩ	b	70	50 Ω	70	6	0,7
220 kΩ	b	100	50 Ω	80	6	0,5
470 kΩ	b	155	100 Ω	80	6	0,32
1 MΩ	b	220	200 Ω	80	6	0,22
2,2 MΩ	b	310	500 Ω	80	6	0,15

* Measured between terminals a and c; for potentiometers with a tap, between terminals a and d and between c and d.

▲ Measured between terminals a and b; spindle turned fully counter-clockwise.

nominal resistance R_n*	resistance law according to Figs 9 and 10	max. voltage at 40 °C V	max. terminal resistance	max. attenuation dB	max. contact resistance % R_n	limiting slider current at 40 °C mA
1 kΩ	c	7	20 Ω	50	6	7
2,2 kΩ	c	10	40 Ω	50	6	5
4,7 kΩ	c	15	100 Ω	60	6	3,2
10 kΩ	c	22	200 Ω	60	6	2,2
22 kΩ	c	31	250 Ω	60	6	1,5
47 kΩ	c	50	500 Ω †	60 †	6	1,0
100 kΩ	c	70	2 kΩ	70	6	0,7
220 kΩ	c	100	2,5 kΩ	80	6	0,5
470 kΩ	c	155	5 kΩ	80	6	0,32
1 MΩ	c	220	10 kΩ	80	6	0,22
2,2 MΩ	c	310	20 kΩ	80	6	0,15
5 + 42 kΩ	d	50	40 Ω	60	6	1,0
20 + 200 kΩ	d	100	50 Ω	80	6	0,5
50 + 420 kΩ	d	155	470 Ω ▲	80 ▲	6	0,32
100 + 900 kΩ	d	220	200 Ω	80	6	0,22
2 + 8 kΩ	e	22	10 Ω	60	6	2,2
5 + 17 kΩ	e	31	22 Ω	60	6	1,5
10 + 37 kΩ	e	50	47 Ω	60	6	1,0
20 + 80 kΩ	e	70	100 Ω ▲	70 ▲	6	0,7
50 + 170 kΩ	e	100	220 Ω	80	6	0,5
100 + 370 kΩ	e	155	600 Ω	80	6	0,32
0,5 + 1,7 MΩ	e	310	2,2 kΩ	80	6	0,15
10 kΩ	f	15	—	--	6	2,2
22 kΩ	f	22	—	—	6	1,5
47 kΩ	f	35	—	—	6	1,0
100 kΩ	f	50	—	—	6	0,7
220 kΩ	f	70	—	—	6	0,5
470 kΩ	f	110	—	—	6	0,32
1 MΩ	f	155	—	—	6	0,22

* Measured between terminals a and c; for potentiometers with a tap, between terminals a and d and between c and d.

† Measured between terminals c and b; spindle turned fully clockwise.

▲ Measured between terminals a and b; spindle turned fully counter-clockwise.

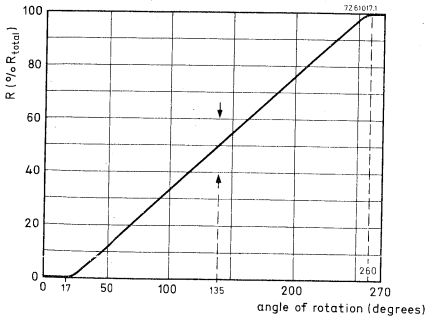


Fig. 9a Linear law, single potentiometers.

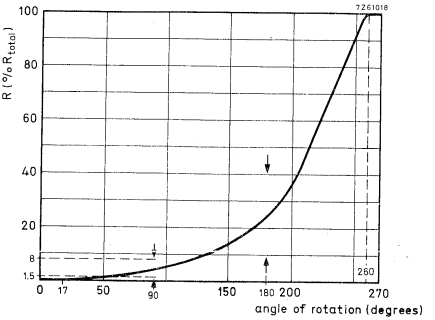


Fig. 9b Logarithmic law, single potentiometers.

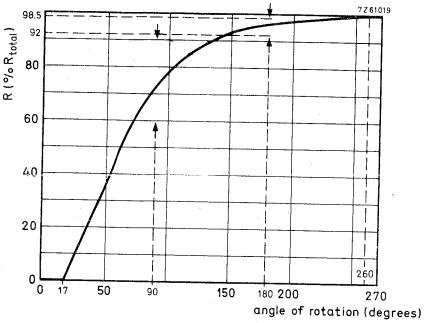


Fig. 9c Reversed logarithmic law, single potentiometers.

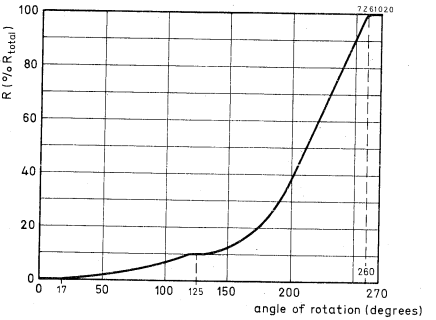


Fig. 9d Semi-logarithmic law, tap at 10%, single potentiometers.

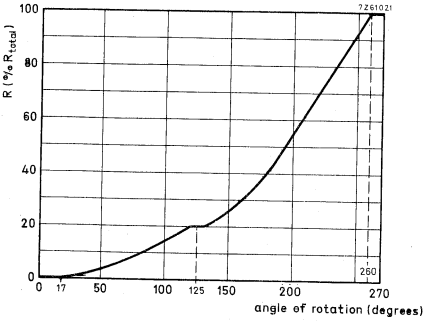


Fig. 9e Semi-logarithmic law, tap at 20%, single potentiometers.

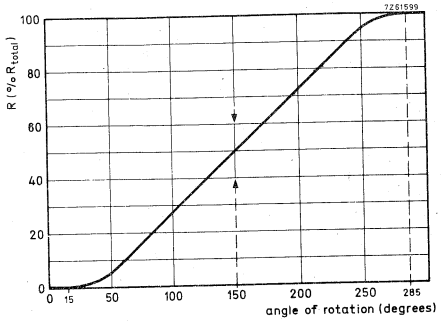


Fig. 10a Linear law, tandem potentiometers.

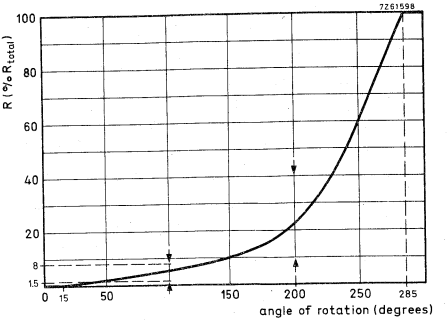


Fig. 10b Logarithmic law, tandem potentiometers.

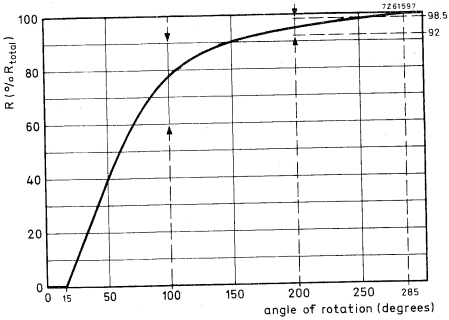


Fig. 10c Reversed logarithmic law, tandem potentiometers.

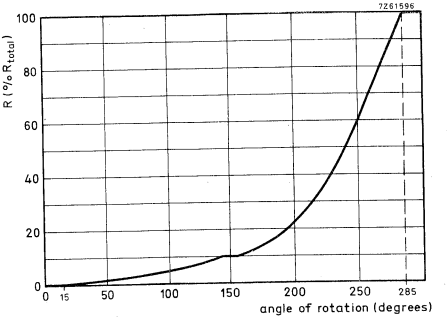


Fig. 10d Logarithmic law, tap at 10% tandem potentiometers.

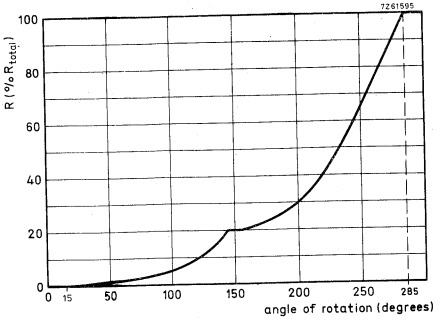


Fig. 10e Logarithmic law, tap at 20%, tandem potentiometers.

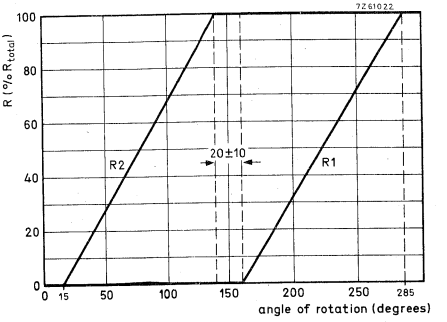


Fig. 10f Balance potentiometers.

Tolerance on the nominal resistance	± 20% (note 1)
Resistance law and tolerances	see Figs 9 and 10
Ganging tolerance (note 2)	
linear law	
at values between 10 and 90% of R_{total}	< 2 dB
(reserved) logarithmic law	
at attenuations between 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −40 dB	< 4 dB
with a tap	
at attenuations between 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −34 dB	< 4 dB
Minimum resistance at the tap	⩽ 1,5% of R_n
Insulation resistance,	
initially	> 1000 MΩ
after damp heat test (IEC 68, test C, 21 days)	> 25 MΩ
Maximum dissipation at 40 °C	
linear law, acc. to Figs 9a, 10a	0,1 W
resistance law, acc. to Figs 9b(10b) to 9e(10f)	0,05 W
Test voltage	1000 V, 50 Hz
Working temperature range	−10 to + 70 °C
Storage temperature range	−25 to + 70 °C
Category (IEC 68)	10/070/21
Operating torque	5 to 20 mNm

Permissible torque with slider at end stop	plastic	metal
plain spindles	⩽ 500 mNm	⩽ 600 mNm
spindles with flat face	⩽ 400 mNm	⩽ 600 mNm
spindles with screwdriver slot	⩽ 250 mNm	⩽ 600 mNm
Permissible axial spindle load		
single potentiometers	⩽ 100 N pull	⩽ 100 N push
tandem potentiometers	⩽ 100 N pull	⩽ 60 N push
Axial spindle play	< 0,8 mm	
Radial spindle play, measured with 2,5 N		
at 10 mm from the mounting plane	⩽ 0,2 mm	
potentiometers with mounting bushing	⩽ 0,5 mm	
potentiometers with twist tags		
Effective angle of rotation		
single	235 − 250°	
tandem	265 − 275°	
balance	range of balance, half the effective angle of rotation: 20 ± 10°	
	R_2: 125 ± 10° (counter-clockwise)	
	R_1: 125 ± 10° (clockwise)	

1. For potentiometers with a tap the tolerance on Rad as well as Rdc = ± 20%.
2. For tandem potentiometers only.

Mechanical angle of rotation single potentiometers
without switch
with switch
tandem potentiometers

270 ± 5^{o}
292 ± 5^{o}
300 ± 5^{o}

Life

after 10 000 cycles ΔR_{total}
$< 25\%$ of R_{total}

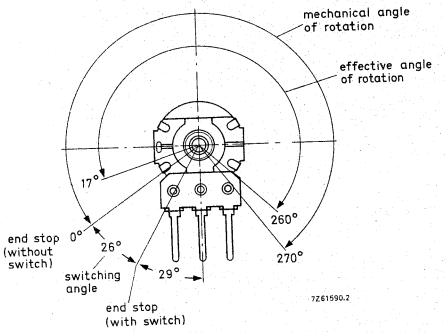


Fig. 11a Angles of rotation of single potentiometers with or without switch.

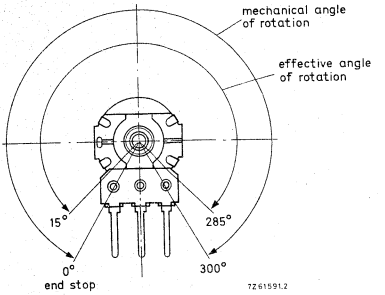


Fig. 11b Angles of rotation of tandem potentiometers.

	switch type	
	s.p.s.t. rotary spring actuated	s.p.s.t. rotary direct operating
Breaking capacity	12 V d.c., 2 A	12 V d.c., 2 A
Contact resistance, initially after 10 000 on-off switching operations at breaking capacity	< 10 mΩ < 50 mΩ*	< 10 mΩ < 50 mΩ*
Insulation resistance** initially after damp heat test (IEC 68, test C_a, 21 days)	> 10 MΩ > 2 MΩ	> 10 MΩ > 2 MΩ
Test voltage for 1 min**, initially after damp heat test (IEC 68, test C_a, 21 days)	500 V (d.c.) 100 V (d.c.)	500 V (d.c.) 100 V (d.c.)
Switching torque	15 to 40 mNm	12 to 30 mNm
Switching angle	26 ± 2^{o}	26 ± 2^{o}
Total mechanical angle of rotation	295 ± 5^{o}	295 ± 5^{o}
Backlash	$\leqslant 10^{o}$	$\leqslant 10^{o}$
Permissible axial spindle load	$\leqslant 100$ N	$\leqslant 100$ N

* Averaged over 10 measurements: < 25 mΩ.
** Measured between the terminals, and between interconnected terminals and the case or other metal parts.

COMPOSITION OF THE CATALOGUE NUMBER

2322 . . . . . .

code for type and switch

- without switch: single = 380; tandem = 390
- single, with s.p.s.t. rotary switch (spring actuated)* = 381
- single, with s.p.s.t. rotary switch (direct operating) = 387
- single, without switch, with p.w. pins bent backwards** = 389

code for terminals, mounting facility, spindle type and length

solder tags			
mounting bushing		twist tags	
metal spindle	plastic spindle	metal spindle	plastic spindle
0 . .	7 . .	2 . .	4 . .

p.w. pins, length 4,5 mm				p.w. pins, length 9,3 mm			
mounting bushing		twist tags		mounting bushing		twist tags	
metal spindle	plastic spindle	metal spindle	plastic spindle	metal spindle	plastic spindle	metal spindle	plastic spindle
0 . .	7 . .	2 . .	4 . .	1 . .	6 . .	3 . .	5 . .

plain:

solder tags	p.w. pins, length 4,5 mm / 9,3 mm
10 mm = . 11	10 mm = . 61
12 mm = . 09	12 mm = . 59
15 mm = . 12	15 mm = . 62
17 mm = . 13	17 mm = . 63
19 mm = . 14	19 mm = . 64
20 mm = . 15	20 mm = . 65
22 mm = . 17	22 mm = . 67
24 mm = . 19	24 mm = . 69
25 mm = . 01	25 mm = . 51
28 mm = . 02	28 mm = . 52
30 mm = . 03	30 mm = . 53

with flat face:

solder tags	p.w. pins, length 4,5 mm / 9,3 mm
10 (L_1 = 3,5) mm = . 42	10 (L_1 = 3,5) mm = . 92
15 (L_1 = 8,5) mm = . 44	15 (L_1 = 8,5) mm = . 94
20 (L_1 = 8,5) mm = . 45	20 (L_1 = 8,5) mm = . 95
20 (L_1 = 13,5) mm = . 46	20 (L_1 = 13,5) mm = . 96

knurled (only plastic):

solder tags	p.w. pins, length 4,5 mm / 9,3 mm
10 mm = . 26	10 mm = . 76
15 mm = . 27	15 mm = . 77
20 mm = . 28	20 mm = . 78

with screwdriver slot = . 10 (solder tags) / = . 60 (p.w. pins)

code for resistance law and nominal resistance, see table next page

* Only available with mounting bushing.

** Only available with mounting bushing and p.w. pins of 9,3 mm length.

nominal resistance	code in catalogue number			
	linear law Fig. 9a, 10a	log. law Fig. 9b, 10b	rev. log. law Figs 9c, 10c	balance Fig. 10f
220 Ω	02			
470 Ω	03			
1 kΩ	04	24	44	
2,2 kΩ	05	25	45	
4,7 kΩ	06	26	46	
10 kΩ	07	27	47	91
22 kΩ	08	28	48	92
47 kΩ	09	29	49	93
100 kΩ	11	31	51	94
220 kΩ	12	32	52	95
470 kΩ	13	33	53	96
1 MΩ	14	34	54	97
2,2 MΩ	15	35	55	
4,7 MΩ	16			

nominal resistance	code in catalogue number	
	log. law tap at 10% Figs 9d, 10d	log. law tap at 20% Figs 9e, 10e
5 + 42 kΩ	72	
20 + 200 kΩ	67	
50 + 420 kΩ	73	
100 + 900 kΩ	64	
2 + 8 kΩ		76
5 + 17 kΩ		82
10 + 37 kΩ		86
20 + 80 kΩ		77
50 + 170 kΩ		83
100 + 370 kΩ		87
0,5 + 1,7 MΩ		84

Note

Detent potentiometers (11 click, 41 click and centre click versions), without switch, can be supplied on request.

Only for tandem potentiometers.

23 mm CARBON CONTROL POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range	
linear law	220 Ω - 4,7 MΩ
logarithmic law	1 kΩ - 4,7 MΩ
Maximum dissipation at 40 °C	
linear law	0,25 W
logarithmic law	0,125 W
Climatic category (IEC 68)	10/070/21

APPLICATION

The potentiometers are widely used in video and audio equipment.

DESCRIPTION

The CP23 carbon control potentiometer series includes three types:

- single potentiometers, for general purposes;
- tandem potentiometers, for stereophonic purposes;
- twin potentiometers, for combined controls.

The single potentiometers comprise a carbon track, which is fitted on to a base plate of resin bonded paper and housed in a metal case. The terminals a and c (see Types) are connected to the ends of the carbon track; terminal b is connected via a contact ring to the slider contact. The potentiometers can be supplied with a tap (d) at 40% of the total mechanical angle of rotation. The material of the spindle is plastic or metal.

The tandem potentiometers are composed of two single potentiometers which are ganged; their resistance values and gradings are identical within narrow limits.

The twin potentiometers are composed of two single potentiometers R_1 and R_2; potentiometer R_1 is operated by means of a hollow metal spindle or a hollow plastic spindle, through which a metal spindle protrudes for the operation of potentiometer R_2.

Single, tandem and twin potentiometers can be delivered without switch, with rotary switch or with a push-pull switch; triple potentiometers are only available without switch.

Single and tandem potentiometers are available with different connecting terminals, mounting facilities and spindles.

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

Types

For dimensions d, L and L1, see Spindles.

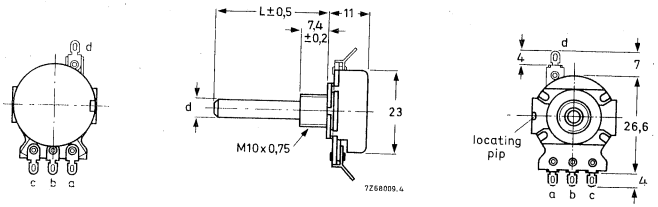


Fig. 1 Single potentiometer with mounting bushing.

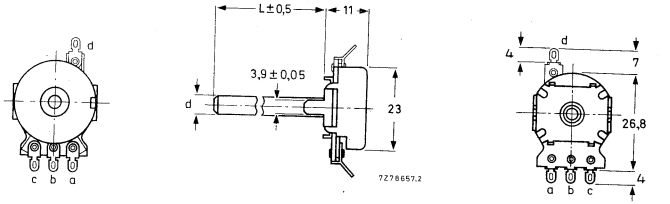


Fig. 2 Single potentiometer with twist tags.

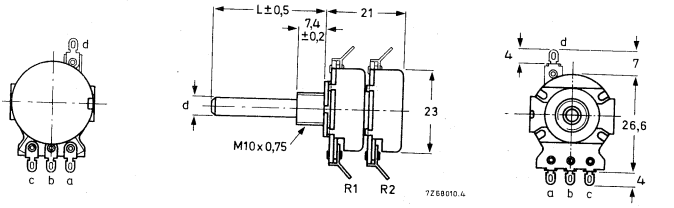


Fig. 3 Tandem potentiometer.

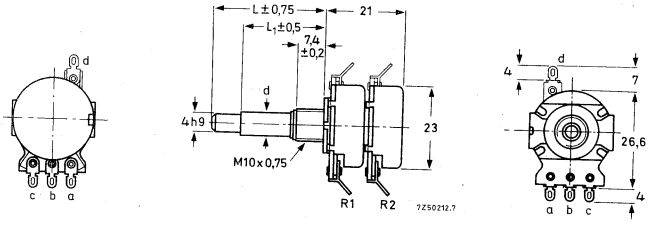
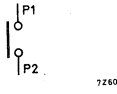
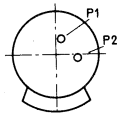
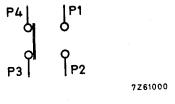
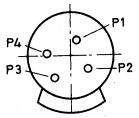
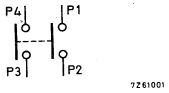
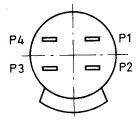
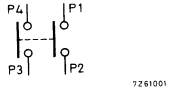
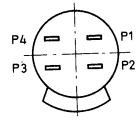


Fig. 4 Twin potentiometer.

Switches

type	circuit in "off"-position of spindle	position of terminals	Fig.	available with potentiometer type
single-pole, single-throw rotary switch (s.p.s.t.)			5 6 6	single tandem twin
single-pole, double-throw rotary switch (s.p.d.t.)			7 8	single tandem twin
double-pole, single-throw rotary switch (d.p.s.t.)			9 10 10	single tandem twin
double-pole, single-throw push-pull switch 2A (d.p.s.t.)			11 12 12	single tandem twin

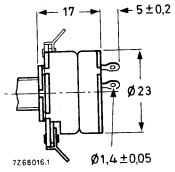


Fig. 5 S.P.S.T. rotary switch (single potentiometer).

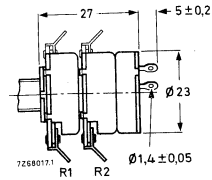


Fig. 6 S.P.S.T. rotary switch (tandem or twin potentiometer).

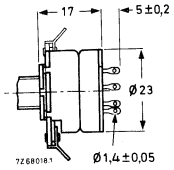


Fig. 7 S.P.D.T. rotary switch (single potentiometer).

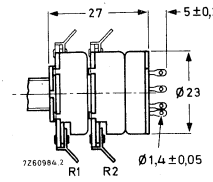


Fig. 8 S.P.D.T. rotary switch (tandem or twin potentiometer).

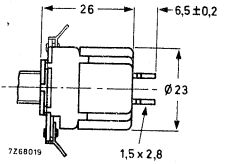


Fig. 9 D.P.S.T. rotary switch (single potentiometer).

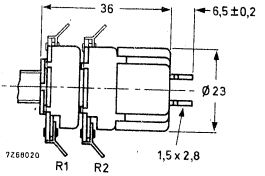


Fig. 10 D.P.S.T. rotary switch (tandem or twin potentiometer).

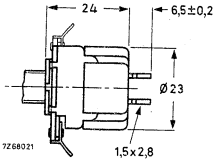


Fig. 11 D.P.S.T. push-pull switch (single potentiometer).

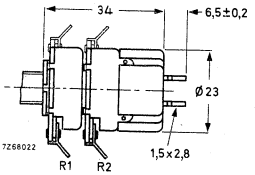


Fig. 12 D.P.S.T. push-pull switch (tandem or twin potentiometer).

Mounting facilities

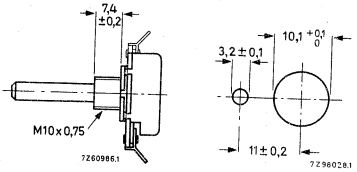
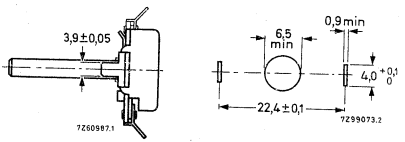
method	required mounting holes in chassis	fixing of potentiometer
mounting bushing M10 x 0,75		with supplied mounting nut (catalogue number 4322 047 00350) max. torque for tightening = 3,5 Nm; min. thickness of chassis = 1,5 mm
twist tags Note: not for twin potentiometers		by twisting the tags

Fig. 13.

Fig. 14.

Connecting terminals

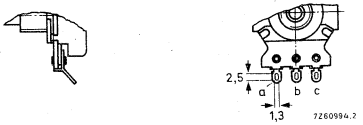


Fig. 15 Solder tags.

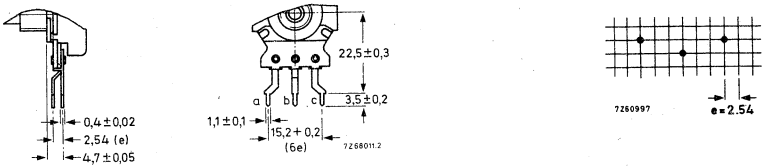


Fig. 16 Long printed-wiring pins, pin distance 15,2 mm (6e), single potentiometer.

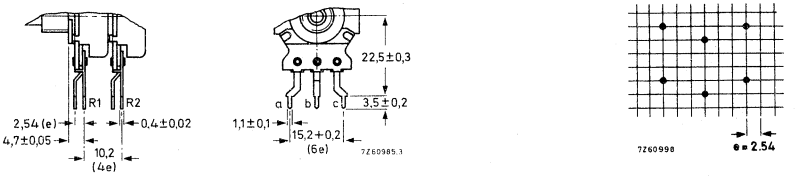


Fig. 17 Long printed-wiring pins, pin distance 15,2 mm (6e), tandem potentiometer.

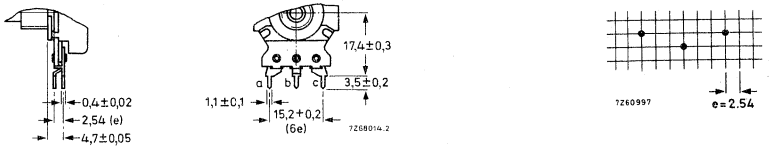


Fig. 18 Short printed-wiring pins, pin distance 15,2 mm (6e), single potentiometer.

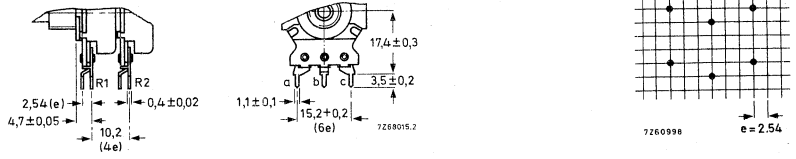
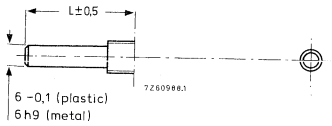
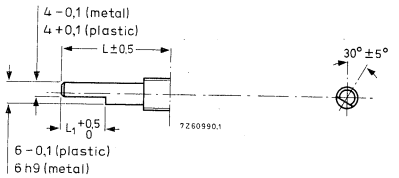
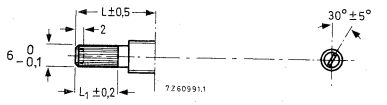
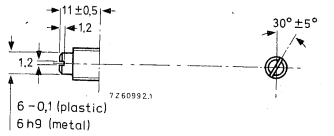
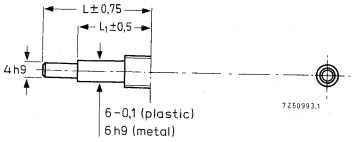


Fig. 19 Short printed-wiring pins, pin distance 15,2 mm (6e), tandem potentiometer.

Spindles

type	"off position"	L mm	L_1 mm	available with potentiometer type
		17 18 19 20 22 25 30 35 40 60 70 90		single tandem
		18 25 28 30 35 40 60 70 90	8,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5	single tandem
		18 30 60	8 12 12	single tandem
				single tandem (not for potentiometers with push-pull switch)
		30,5 42,5	18 30	twin

Note: For potentiometers with push-pull switch the length L applies to "off-position" of switch.

TECHNICAL DATA

Unless otherwise specified, all values have been determined at an ambient temperature of 15 to 35 °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

For measuring methods, see IEC publications 190 and 68. For the terms used, the Glossary of terms should be consulted.

nominal resistance R_n*	resistance law according to Fig. 20	max voltage (V) at 40 °C	max voltage (V) at 70 °C	max terminal resistance	max attenuation dB	max contact resist. % R_n	limiting slider current at 40 °C mA
220 Ω	a	7,4	5,7	10 Ω	–	3	40
330 Ω	a	8,7	6,7	10 Ω	–	3	30
470 Ω	a	11	8,4	10 Ω	–	3	22
1 kΩ	a	16	12	25 Ω	–	3	16
2,2 kΩ	a	23	18	25 Ω	–	3	11
4,7 kΩ	a	34	26	25 Ω	–	3	7
10 kΩ	a	50	39	35 Ω	–	2,5	5
22 kΩ	a	74	57	35 Ω	–	2,5	3,5
47 kΩ	a	110	84	35 Ω	–	2,5	2,2
100 kΩ	a	160	120	100 Ω	–	2,5	1,4
220 kΩ	a	230	180	125 Ω	–	2,5	1,0
470 kΩ	a	340	265	250 Ω	–	2,5	0,65
1 kΩ	a	500	390	1 kΩ	–	2,5	0,45
2,2 MΩ	a	500	500	2,2 kΩ	–	2,5	0,32
4,7 MΩ	a	500	500	4,7 kΩ	–	2,5	0,22
470 Ω	b	8,4	6,9	5 Ω	–	6	14
1 kΩ	b	12	10	5 Ω	50	4	10
2,2 kΩ	b	18	15	5 Ω	60	4	7
4,7 kΩ	b	26	22	5 Ω	60	4	4,5
10 kΩ	b	39	32	10 Ω	60	4	3,2
22 kΩ	b	57	47	22 Ω	60	4	2,2
47 kΩ	b	84	69	35 Ω ▲	70 ▲	4	1,4
100 kΩ	b	120	100	50 Ω	70	4	1,0
220 kΩ	b	180	150	50 Ω	80	4	0,7
470 kΩ	b	265	220	100 Ω	80	4	0,45
1 MΩ	b	390	320	500 Ω	80	4	0,32
2,2 MΩ	b	500	470	2,2 kΩ	80	4	0,22

* Measured between terminals a and c; for potentiometers with a tap, between terminals a and d and between c and d.

▲ Measured between terminals a and b; spindle turned fully counter-clockwise.

nominal resistance R_n *	resistance law according to Fig.20	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resistance	max. attenuation dB	max. contact resist. % R_n	limiting slider current at 40 °C mA
330 Ω	c	6,7	5,5	20 Ω †	– †	6	20
470 Ω	c	8,4	6,9	20 Ω †	– †	6	14
1 kΩ	c	12	10	50 Ω †	50 †	4	10
2,2 kΩ	c	18	15	50 Ω †	60 †	4	7
4,7 kΩ	c	26	22	100 Ω †	60 †	4	4,5
10 kΩ	c	39	32	200 Ω †	60 †	4	3,2
22 kΩ	c	57	47	250 Ω †	60 †	4	2,2
47 kΩ	c	84	69	500 Ω †	70 †	4	1,4
100 kΩ	c	120	100	2 kΩ †	70 †	4	1,0
220 kΩ	c	180	150	2,5 kΩ †	80 †	4	0,7
470 kΩ	c	260	220	5 kΩ †	80 †	4	0,45
1 MΩ	c	390	320	20 kΩ †	80 †	4	0,32
2,2 MΩ	c	500	470	44 kΩ †	80 †	4	0,22
20 + 200 kΩ	d	180	150	50 Ω ▲	80 ▲	4	0,7
50 + 420 kΩ	d	265	220	100 Ω ▲	80 ▲	4	0,45
100 + 900 kΩ	d	390	320	500 Ω ▲	80 ▲	4	0,32
0,2 + 2 MΩ	d	500	470	2,2 kΩ ▲	80 ▲	4	0,22
0,5 + 1,7 kΩ	e	18	15	5 Ω ▲	60 ▲	4	7
5 + 17 kΩ	e	57	47	22 Ω ▲	60 ▲	4	2,2
10 + 37 kΩ	e	84	69	47 Ω ▲	70 ▲	4	1,4
20 + 80 kΩ	e	120	100	100 Ω ▲	70 ▲	4	1,0
50 + 170 kΩ	e	180	150	220 Ω ▲	80 ▲	4	0,7
100 + 370 kΩ	e	265	220	470 Ω ▲	80 ▲	4	0,45
200 + 800 kΩ	e	390	320	1 kΩ ▲	80 ▲	4	0,32
0,5 + 1,7 MΩ	e	500	470	2,2 kΩ ▲	80 ▲	4	0,22
400 + 600 kΩ	f	500	390	1 kΩ ▲	60 ▲	2,5	0,45
200 + 100 kΩ	g	210	170	3 kΩ ▲	– ▲	4	0,7
22 kΩ	h	50	35	–	–	4	3,5
47 kΩ	h	80	55	–	–	4	2,2
100 kΩ	h	110	80	–	–	4	1,4
220 kΩ	h	160	110	–	–	4	1,0
470 kΩ	h	250	175	–	–	4	0,65
1 MΩ	h	350	250	–	–	4	0,45

* Measured between terminals a and c; for potentiometers with a tap, between terminals a and d and between c and d.

† Measured between terminals c and b; spindle turned fully clockwise.

▲ Measured between terminals a and b; spindle turned fully counter-clockwise.

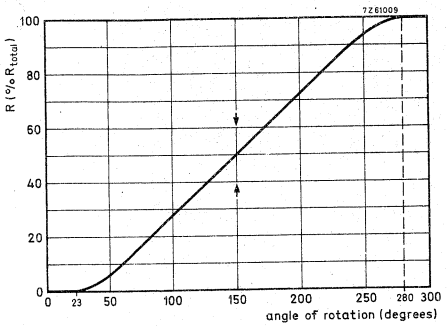


Fig. 20a Linear law.

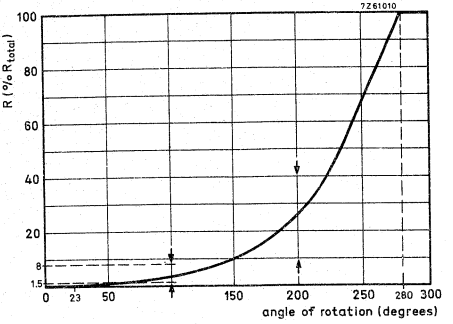


Fig. 20b Logarithmic law.

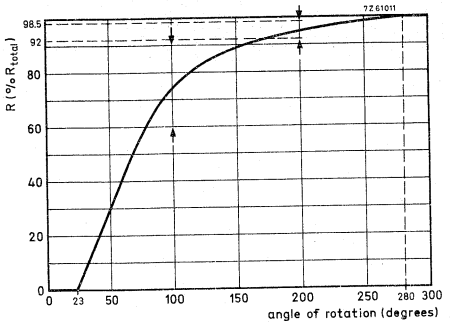


Fig. 20c Reversed logarithmic law.

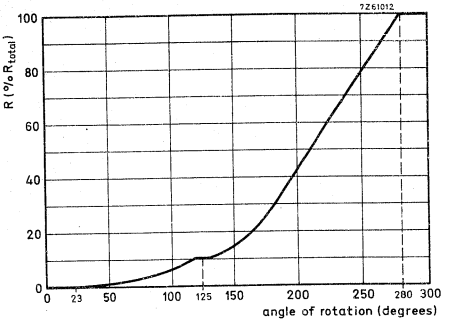


Fig. 20d Semi-logarithimic law, tap at 10%.

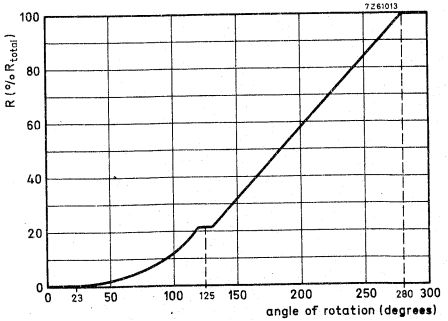


Fig. 20e Semi-logarithmic law, tap at 20%.

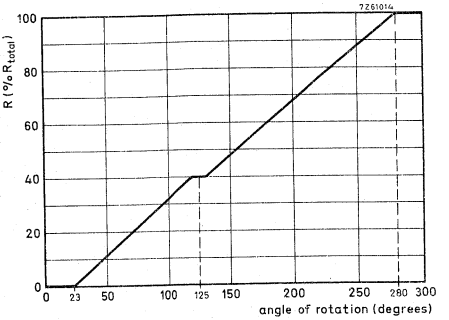


Fig. 20f Linear law, tap at 40%.

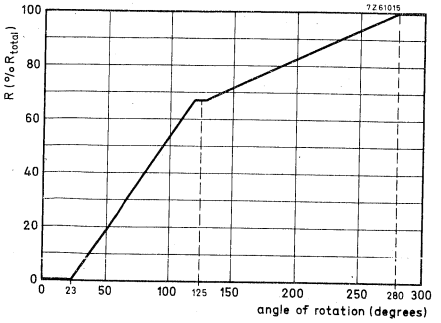


Fig. 20g Linear law, tap at 67%.

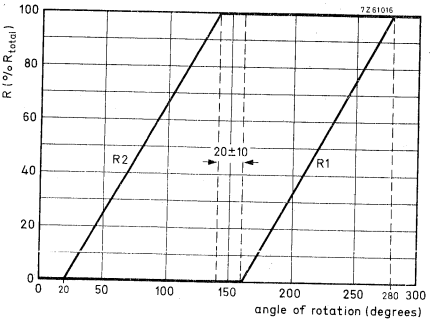


Fig. 20h Balance potentiometers.

TECHNICAL DATA

Tolerance on the nominal resistance	± 20%*
Resistance law and tolerances	see Figs 20a to 20h
Ganging tolerance (for tandem types)	
linear law	
at values between 10 and 90% of R_{total}	< 2 dB
with a tap at 40% and	
at attenuations between 0 and –20 dB	< 2 dB
at attenuations between –20 and –28 dB	< 3 dB
(reversed) logarithmic law	
at attenuations between 0 and –20 dB	< 2 dB
at attenuations between –20 and –30 dB	< 3 dB
at attenuations between –30 and –40 dB	< 4 dB
with a tap at 10% or 20% and	
at attenuations between 0 and –20 dB	< 2 dB
at attenuations between –20 and –30 dB	< 3 dB
at attenuations between –30 and –34 dB	< 4 dB
Minimum resistance at the tap	⩽ 1% of R_n
Insulation resistance after damp heat test (IEC68, test C, 21 days)	> 100 MΩ
Maximum dissipation	
linear law, acc. to Fig. 20a	
at 40 °C	0,25 W
at 70 °C	0,125 W
resistance law, acc. to Figs 20b to 20h	
at 40 °C	0,125 W
at 70 °C	0,0625 W
Test voltage	1000 V, 50 Hz
Working temperature range	–10 to + 70 °C
Category (IEC68)	10/070/21
Operating torque	
single and twin potentiometers	3 to 20 mNm
tandem and triple potentiometers	7 to 35 mNm
Permissible torque with slider at end stop	⩽ 0,8 Nm

* For potentiometers with a tap the tolerance on R_1 as well as on R_2 is ± 20%.

Permissible axial spindle load	$\leqslant$ 100 N
Effective angle of rotation	250-265°
Mechanical angle of rotation	300 ± 5°
Life	after 10 000 rotations
	$\Delta R_{total} < 25\%$ of R_{total}

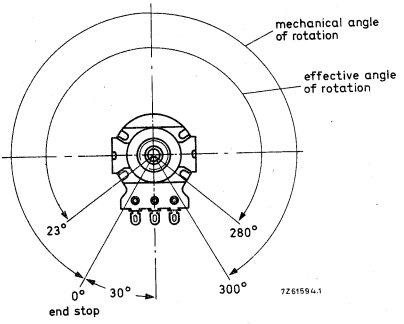


Fig. 21a Angles of rotation of potentiometers without switch or with a push-pull switch.

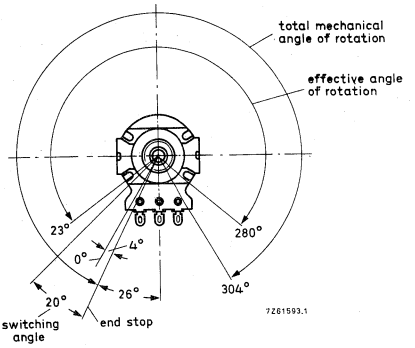


Fig. 21b Angles of rotation of potentiometers with a s.p.s.t. rotary switch.

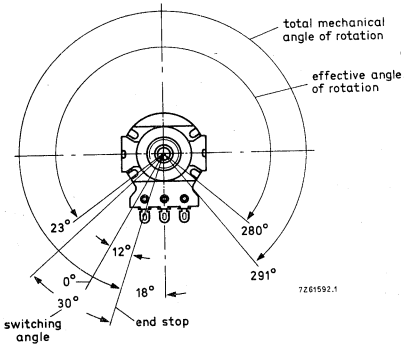


Fig. 21c Angles of rotation of potentiometers with a d.p.s.t. rotary switch.

	switch type			
	rotary s.p.s.t.	rotary s.p.d.t.	rotary d.p.s.t.	push-pull d.p.s.t., 2A
Approved by →			E.I., Demko, Semko, Nemko	Demko, Semko, Nemko
Breaking capacity	250 V a.c., 0,5 A, cos φ = 0,9 125 V a.c., 1 A, cos φ = 0,9	250 V a.c., 0,5 A, cos φ = 0,9 125 V a.c., 1 A, cos φ = 0,9	250 V a.c., 1,5 A/32 x (IEC65)	250 V a.c., 2 A/32 x (IEC65)
Contact resistance, initially after damp heat test (IEC68, test C, 21 days) after 10 000 on-off switching operations at breaking capacity	< 25 mΩ < 40 mΩ ⩽ 200 mΩ (2)	< 25 mΩ < 40 mΩ ⩽ 200 mΩ (2)	< 20 mΩ (1) < 40 mΩ ⩽ 200 mΩ (2)	< 20 mΩ (1) < 40 mΩ ⩽ 200 mΩ (2)
Insulation resistance, initially after damp heat test (IEC68, test C, 21 days)	> 100 MΩ > 2 MΩ	> 100 MΩ > 2 MΩ	> 5000 MΩ > 25 MΩ	> 5000 MΩ > 25 MΩ
Test voltage (5), initially after damp heat test (IEC68, test C, 21 days) (6)	2000 V, 50 Hz 500 V, 50 Hz	2000 V, 50 Hz 500 V, 50 Hz	2000 V, 50 Hz 2000 V, 50 Hz	2200 V, 50 Hz 2200 V, 50 Hz
Switching torque Switching force	4 - 8 Ncm (3) 4 - 9,5 Ncm (4)	4 - 8 Ncm (3) 4 - 9,5 Ncm (4)	4 - 8 Ncm (3) 4 - 9,5 Ncm (4)	3,5 - 4,5 N
Switching angle Switching stroke	20 ± 2°	20 ± 2°	25 - 35°	3,5 mm
Total mechanical angle of rotation	308 ± 5°	308 ± 5°	303 ± 5°	300 ± 5°
Backlash (rotary switch)	⩽ 6°	⩽ 6°	–	
Backlash (push-pull switch)				⩽ 9°
Permissible axial spindle load	⩽ 100 N	⩽ 100 N	⩽ 100 N	⩽ 100 N

1. Measured per contact (e.g. between P_1 and P_2, see "Switches").
2. Averaged over 10 measurements: ⩽ 100 mΩ.
3. For single and twin potentiometers.
4. For tandem potentiometers.
5. Measured at opened switch between the terminals, and between the case or spindle and interconnected terminals.
6. Measured after recovery period of 24 hours.

COMPOSITION OF THE CATALOGUE NUMBER Single and tandem types

2322 . . . . . .

code for type and switch

without switch	single	= 350
	tandem	= 360
with s.p.d.t. rotary switch	single	= 352
	tandem	= 363
with s.p.s.t. rotary switch	single	= 353
	tandem	= 362
with d.p.s.t. push-pull switch, 2A	single	= 355
	tandem	= 365
with d.p.s.t. rotary switch	single	= 357
	tandem	= 366

code for terminals, mounting facility, type, and length of spindle

code for resistance law and nominal resistance, see tables below

solder tags

mounting bushing – plastic spindle	7 . .
mounting bushing – metal spindle	0 . .
twist tags – plastic spindle	4 . .

slotted = .10

plain	17 mm = .13	flat faced	18 mm = .40
	18 mm = .06		
	19 mm = .14		
	20 mm = .15		
	22 mm = .17		
	25 mm = .01		25 mm = .41
			28 mm = .42
	30 mm = .03		30 mm = .43
	35 mm = .04		35 mm = .44
	40 mm = .05		40 mm = .45
	60 mm = .07		60 mm = .47
	70 mm = .08*		70 mm = .48*
	90 mm = .09*		90 mm = .49*

knurled, plastic only	18 mm = .11	
	30 mm = .12	
	60 mm = .31	

p.w. pins plastic spindle

mounting bushing, long p.w. pins	3 . .
mounting bushing, short p.w. pins	2 . .
twist tags, long p.w. pins	5 . .
twist tags, short p.w. pins	6 . .

slotted = .60

plain	17 mm = .63	flat faced	18 mm = .90
	18 mm = .56		
	19 mm = .64		
	20 mm = .65		
	22 mm = .67		
	25 mm = .51		25 mm = .91
			28 mm = .92
	30 mm = .53		30 mm = .93
	35 mm = .54		35 mm = .94
	40 mm = .55		40 mm = .95
	60 mm = .57		60 mm = .97
	70 mm = .58		70 mm = .98
	90 mm = .59		90 mm = .99

knurled	18 mm = .61	
	30 mm = .62	
	60 mm = .81	

* With plastic spindle, not for version 365 (tandem + p.p).

Twin types

2322 . . . . . .

- code for type, switch and hollow spindle
  - steel hollow spindle

without switch	twin	= 370
	triple	= 378
with s.p.d.t. rotary switch	twin	= 372
with s.p.s.t. rotary switch	twin	= 373
with d.p.s.t. push-pull switch, 2A	twin	= 375
with d.p.s.t. rotary switch	twin	= 376

  - plastic hollow spindle

without switch	twin	= 470
	triple	= 478
with s.p.d.t. rotary switch	twin	= 472
with s.p.s.t. rotary switch	twin	= 473
with d.p.s.t. push-pull switch, 2A	twin	= 475
with d.p.s.t. rotary switch	twin	= 476

- code for resistance law and nominal resistance of potentiometer R_2, see tables below
- code for resistance law and nominal resistance of potentiometer R_1, see tables below
- code for spindle lengths
  - plastic hollow spindle
    - 18 and 30,5 mm = 0
    - 30 and 42,5 mm = 1
  - steel hollow spindle
    - 18 and 30,5 mm = 6
    - 30 and 42,5 mm = 7

nominal resistance	code in catalogue number			
	lin. law Fig. 20a	log. law Fig. 20b	rev.log.law Fig. 20c	balance Fig. 20h
220 Ω	02			
330 Ω	19		59	
470 Ω	03	23	43	
1 kΩ	04	24	44	
2,2 kΩ	05	25	45	
4,7 kΩ	06	26	46	
10 kΩ	07	27	47	
22 kΩ	08	28	48	92
47 kΩ	09	29	49	93
100 kΩ	11	31	51	94
220 kΩ	12	32	52	95
470 kΩ	13	33	53	96
1 MΩ	14	34	54	97
2,2 MΩ	15	35	55	
4,7 MΩ	16			

nominal resistance	code in catalogue number			
	log.law tap at 10% Fig. 20d	log.law tap at 20% Fig. 20e	lin.law tap at 40% Fig. 20f	lin.law tap at 67% Fig. 20g
20 + 200 kΩ	67			
50 + 420 kΩ	73			
100 + 900 kΩ	64			
0,2 + 2 MΩ	68			
0,5 + 1,7 kΩ		81		
5 + 17 kΩ		82		
10 + 37 kΩ		86		
20 + 80 kΩ		77		
50 + 170 kΩ		83		
100 + 370 kΩ		87		
200 + 800 kΩ		78		
0,5 + 1,7 MΩ		84		
400 + 600 kΩ			89	
200 + 100 kΩ				65

Note
Detent potentiometers (11 click, 41 click and centre-click versions), without switch, can be supplied on request.

25 mm SLIDE CARBON POTENTIOMETERS

QUICK REFERENCE DATA

Nominal resistance	
linear law	1 kΩ – 4,7 MΩ
logarithmic law	1 kΩ – 2,2 MΩ
Climatic category, IEC68	25/070/21

APPLICATION

These potentiometers are particularly suitable for use in radio and television receivers.

DESCRIPTION

A straight carbon track is fitted on to a base plate of resin bonded paper, which is mounted in a housing of black synthetic resin. The terminals are suited for mounting on printed-wiring boards.

The slider contact is adjusted by means of a knob, which moves along a silvered spindle. Two types of slider knob are available. The potentiometers are available with linear or logarithmic resistance law.

COMPOSITION OF THE CATALOGUE NUMBER

2322 415 . 00 . .

code for slider

1 = symmetrically placed (Fig. 1a)
2 = asymmetrically placed (Fig. 1b)

code for nominal resistance

nominal resistance	code in catalogue number	
	linear law	logarithmic law
1 kΩ	04	24
2,2 kΩ	05	25
4,7 kΩ	06	26
10 kΩ	07	27
22 kΩ	08	28
47 kΩ	09	29
100 kΩ	11	31
220 kΩ	12	32
470 kΩ	13	33
1 MΩ	14	34
2,2 MΩ	15	35
4,7 MΩ	16	

Outlines

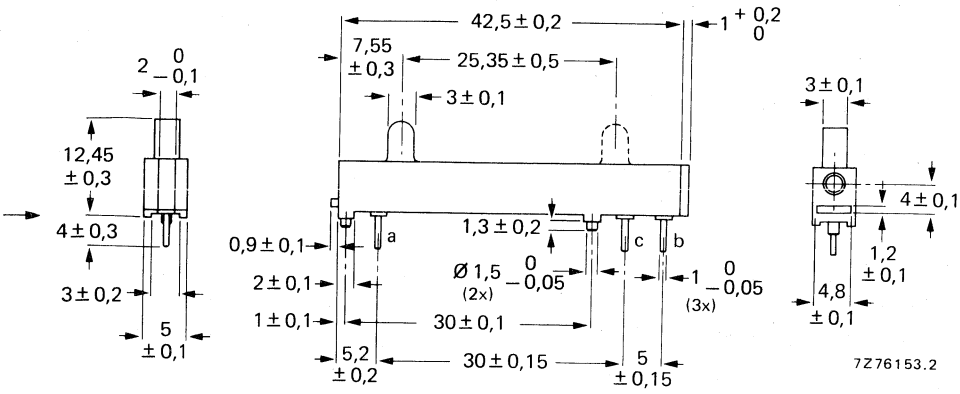


Fig. 1a Potentiometer with symmetrically placed slider.
a and c = beginning and end terminals respectively.
b = slider terminal.

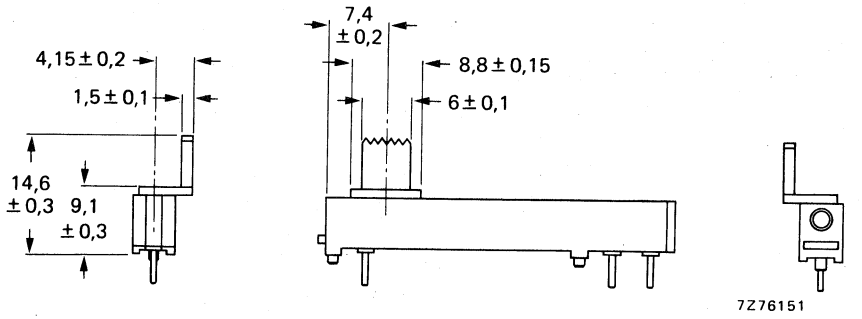


Fig. 1b Potentiometer with asymmetrically placed slider.
Dimensions are identical with those in Fig. 1a except as shown.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

nom. resistance (R_n)	resist. law	max. voltage (V d.c. or V a.c.) T_{amb} = 40 °C, $\Delta R < 20\%$ (note 1)	max. voltage (V d.c. or V a.c.) T_{amb} = 40 °C, $\Delta R < 10\%$ (note 1)	max. voltage (V d.c. or V a.c.) T_{amb} = 70 °C, $\Delta R < 20\%$ (note 1)	max. terminal resistance	max. attenuation (dB)	limiting slider current (mA) $\Delta R < 20\%$ (1) at 40 °C	limiting slider current (mA) $\Delta R < 20\%$ (1) at 70 °C
1 kΩ	linear	17	15,8	12,2	50 Ω	30	17	12
2,2 kΩ		26	23	18	100 Ω	40	11	8,2
4,7 kΩ		37	34	24	200 Ω	40	8	5 ,6
10 kΩ		53	47	37	300 Ω	40	5,3	3,7
22 kΩ		76	66	54	600 Ω	50	3,5	2,4
47 kΩ		108	91	76	1 kΩ	50	2,3	1,6
100 kΩ		152	122	107	2 kΩ	50	1,5	1,1
220 kΩ		217	166	153	3,5 kΩ	60	0,99	0,70
470 kΩ		306	216	216	6 kΩ	60	0,65	0,46
1 MΩ		425	274	300	10 kΩ	70	0,43	0,30
2,2 MΩ		600	330	420	20 kΩ	70	0,27	0,19
4,7 MΩ		840 (2)	340	590	50 kΩ	70	0,18	0,13
1 kΩ	logarithmic	10	8,9	7,1	10 Ω	40	10	7,0
2,2 kΩ		14	12,8	10,2	20 Ω	50	6,6	4,7
4,7 kΩ		20	17,5	14,5	35 Ω	50	4,4	3,0
10 kΩ		29	24	20	50 Ω	50	2,9	2,0
22 kΩ		42	34	29	100 Ω	60	1,9	1,3
47 kΩ		59	47	41	200 Ω (3)	60	1,3	0,9
100 kΩ		85	63	60	250 Ω	60	0,85	0,60
220 kΩ		122	87	86	500 Ω	70	0,55	0,39
470 kΩ		172	112	120	1 kΩ	70	0,37	0,26
1 MΩ		240	141	170	2 kΩ	80	0,24	0,17
2,2 MΩ		350	182	244	5 kΩ	80	0,16	0,11

Notes

1. Measured after 1000 h.
2. Max. 600 V (a.c.).
3. Measured between terminals a and b.

Tolerance on nominal resistance	± 20%
Resistance law	see Fig. 2
Maximum permissible dissipation (P_{max})	see Fig. 3
Contact resistance between carbon track and slider contact	
linear law	⩽ 4% of R_{total}
logarithmic law	⩽ 6% of R_{total}
Operating temperature range	–25 to + 70 °C
Climatic category (IEC68)	25/070/21
Operating force (F)	1 to 2,5 N ($\frac{F_{max}}{F_{min}} \leqslant 2$)
Permissible force with slider at end stop*	⩽ 30 N
Permissible load perpendicular to the direction of movement*	⩽ 10 N
Permissible axial force on slider (push and pull)*	⩽ 20 N
Effective travel of slider contact	24 - 1 mm
Mechanical travel of slider contact	25, 35 ± 0,5 mm
Life	5000 x in both directions

MOUNTING

The terminals may be dip-soldered to a depth of 2 mm max. in a solder bath of 260 °C max. for 4 s max.

When a soldering bit is used, its temperature must not exceed 360 °C for 1,5 s and neither axial nor radial stress must be exerted on the terminals.

MARKING

The potentiometers are marked with nominal resistance, resistance law, period and year of manufacture.

* Measured for 5 s, 5 mm above centre of spindle.

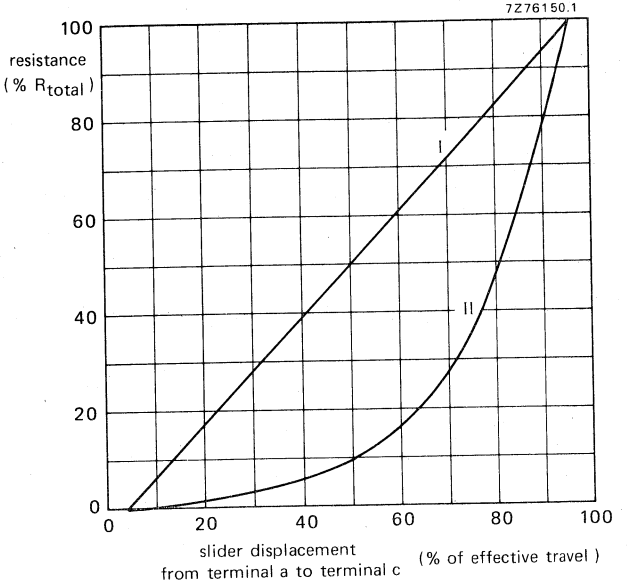


Fig. 2 Resistance as a function of slider displacement.
curve I = linear law;
curve II = logarithmic law.

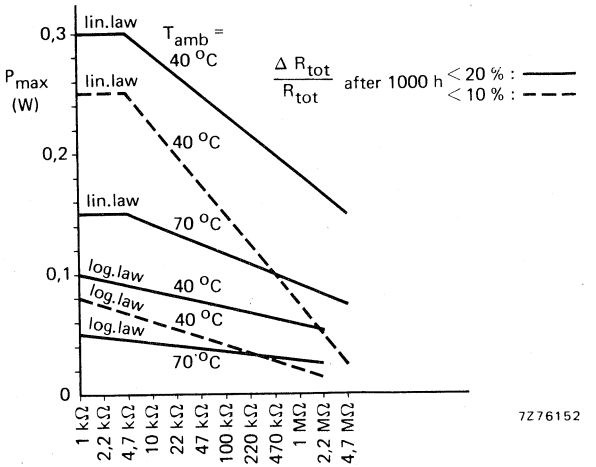


Fig. 3 Maximum permissible power dissipation.

40 mm SLIDE CARBON POTENTIOMETERS

QUICK REFERENCE DATA

Nominal resistance linear law	220 Ω – 4,7 MΩ
logarithmic, reversed logarithmic and semi-logarithmic law	1 kΩ – 2,2 MΩ
Maximum dissipation at 40 °C linear law	0,25 W
logarithmic, reversed logarithmic and semi-logarithmic law	0,125 W
Climatic category (IEC 68)	10/070/21

DESCRIPTION

This slide carbon potentiometer series includes two types:
– single potentiometers, for general purposes,
– tandem potentiometers, for stereophonic purposes.

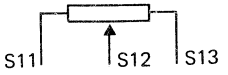
The single potentiometers comprise a straight carbon track, which is fitted on to a base plate of resin bonded paper, mounted in a housing of black synthetic resin.

The tandem potentiometers are composed of two carbon tracks, fitted on base plates of resin bonded paper, which are situated in one housing. The base plates are placed in such a way that the tracks are opposite each other.

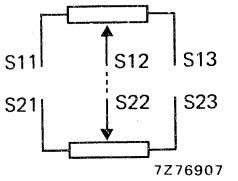
The terminals S_{11},S_{13} (single) and S_{11}/S_{21}, S_{13}/S_{23} (tandem) are connected to the ends of the carbon track (see Figs 1 and 2); terminals S_{12} (single) and S_{22} (tandem) are connected to the slider contact. The potentiometer can be supplied with a tap at 1/2, 1/3 or at 1/3 and 2/3 of the total travel.

Both types are available with or without a metal screening at the outer surface of the potentiometer housing, providing general protection against external interference. The tandem potentiometers can also be supplied with a metal screening between the two carbon tracks, thus preventing crosstalk.

The potentiometers are available with different connecting terminals and adjustment provisions.



Single type



Tandem type

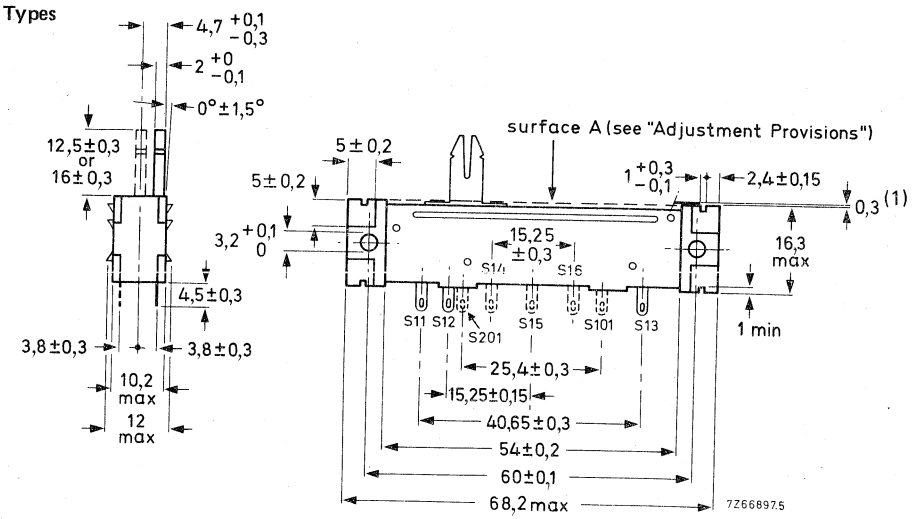


Fig. 1 Single slide potentiometer with solder tags.

S_{11},S_{13} = beginning and end terminals respectively
S_{12} = slider terminal
S_{14},S_{15},S_{16} = tap terminal at 1/3, 1/2 and 2/3 of the total travel respectively
S_{101},S_{201} = earthing terminals (connected to external screening).

(1) Only for potentiometers with external screening.

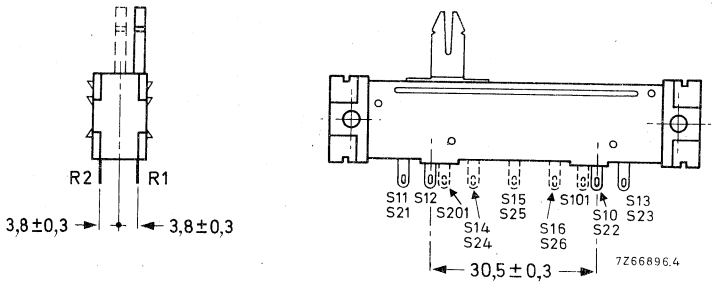


Fig. 2 Tandem slide potentiometer with solder tags.

Dimensions are identical with those in Fig. 1 except as shown.

S_{11},S_{13}	= beginning and end terminals resp.	potentiometer 1 (R1)	S_{21},S_{23}	= beginning and end terminals resp.	potentiometer 2 (R2)
S_{12}	= slider terminal		S_{22}	= slider terminal	
S_{14},S_{15},S_{16}	= tap terminal at 1/3, 1/2 and 2/3 of the total travel resp.		S_{24},S_{25} S_{26}	= tap terminal at 1/3, 1/2 and 2/3 of the total travel resp.	

S_{101},S_{201} = earthing terminals (connected to external screening)
S_{10} = earthing terminal (connected to internal screening).

To determine the side on which potentiometer R1 is situated, the customer should look for the marking: this is always placed at the beginning of R1.

Connecting terminals

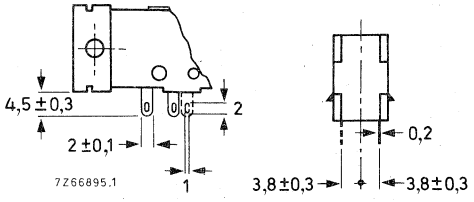


Fig. 3 Solder tags.

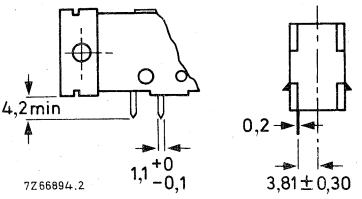


Fig. 4 Printed-wiring pins.

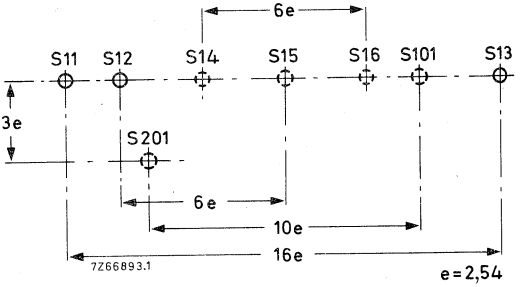


Fig. 5 Hole pattern of the printed-wiring board for a single potentiometer (viewed on component side).

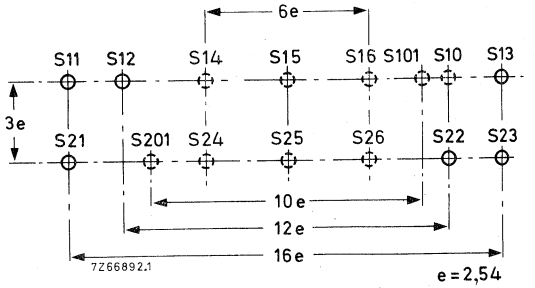


Fig. 6 Hole pattern of the printed-wiring board for a tandem potentiometer (viewed on component side).

Mounting

The potentiometers are available with screw-mounting facility (M3), making use of the holes in top and bottom.

Potentiometers without screw-mounting facility are also available.

Adjustment provisions

Four adjustment sliders are available:
– symmetrically placed, height 12,5 mm or 16 mm
– asymmetrically placed, height 12,5 mm or 16 mm

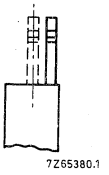


Fig. 7 End view of potentiometer with symmetrically (dotted lines) and asymmetrically placed adjustment slider.

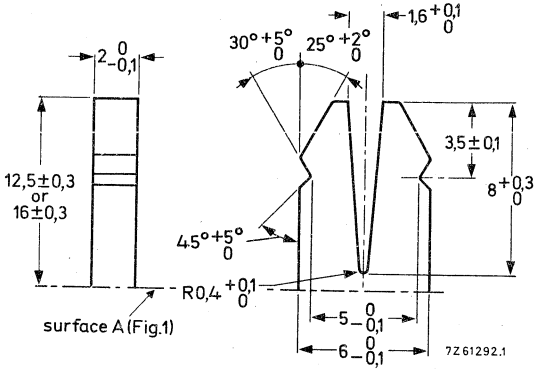


Fig. 8 Adjustment slider.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

	nom. resist. R_n*	resist. law acc. to Fig. 9	tap at	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resist.	max. attenuation dB	max. contact resist. $\%R_n$	limiting slider current at 40 °C mA
linear	220 Ω	a to d	1/3, 1/2 or 1/3 and 2/3	7,4	5,2	10 Ω	–	3	33
	470 Ω	a to d		11	7,7	10 Ω	–	3	23
	1 kΩ	a to d		16	11	25 Ω	–	3	16
	2,2 kΩ	a to d		23	16	25 Ω	–	3	10
	4,7 kΩ	a to d		34	24	25 Ω	–	2,5	7,2
	10 kΩ	a to d		50	35	35 Ω	–	2,5	5
	22 kΩ	a to d		74	52	35 Ω	–	2,5	3,3
	47 kΩ	a to d		108	77	35 Ω	–	2,5	2,3
	100 kΩ	a to d		158	112	100 Ω	–	2,5	1,6
	220 kΩ	a to d		234	166	125 Ω	–	2,5	1,0
	470 kΩ	a to d		342	242	250 Ω	–	2,5	0,72
	1 MΩ	a to d		500	354	1 kΩ	–	2,5	0,50
	2,2 MΩ	a to d		500	500	2,2 kΩ	–	2,5	0,33
	4,7 MΩ	a to d		500	500	4,7 kΩ	–	2,5	0,23
	330 Ω	a to d		9,1	6,4	10 Ω	–	3	27

* Measured between terminals S11 and S13 (or S21 and S23).
** Measured between terminals S11 and S12 (or S21 and S22); slider at the beginning of travel.
▲ Measured between terminals S_{13} and S_{12} (or S_{23} and S_{22}); slider at the beginning of travel.

	nom. resist. R_n*	resist. law acc. to Fig. 9	tap at	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resist.	max. attenuation dB	max. contact resist. %R_n	limiting slider current at 40 °C mA
logarithmic	1 kΩ	e to h	1/3, 1/2 or 1/3 and 2/3	11	7,9	25 Ω	50	4	11
	2,2 kΩ	e to h		16	12	25 Ω	60	4	7,3
	4,7 kΩ	e to h		24	17	25 Ω	60	4	5,1
	10 kΩ	e to h		35	25	35 Ω	60	4	3,5
	22 kΩ	e to h		52	37	35 Ω	70	4	2,4
	47 kΩ	e to h		77	54	35 Ω **	70 **	4	1,6
	100 kΩ	e to h		112	79	50 Ω	80	4	1,1
	220 kΩ	e to h		166	117	50 Ω	80	4	0,73
	470 kΩ	e to h		242	170	100 Ω	80	4	0,51
	1 MΩ	e to h		354	250	500 Ω	80	4	0,35
	2,2 MΩ	e to h		500	370	500 Ω	80	4	0,24
reversed logarithmic	1 kΩ	k to n	1/3, 1/2 or 1/3 and 2/3	11	7,9	100 Ω	50	4	11
	2,2 kΩ	k to n		16	12	100 Ω	60	4	7,3
	4,7 kΩ	k to n		24	17	100 Ω	60	4	5,1
	10 kΩ	k to n		35	25	250 Ω	60	4	3,5
	22 kΩ	k to n		52	37	250 Ω	70	4	2,4
	47 kΩ	k to n		77	54	500 Ω **	70 ▲	4	1,6
	100 kΩ	k to n		112	79	2,5 kΩ	80	4	1,1
	220 kΩ	k to n		166	117	2,5 kΩ	80	4	0,73
	470 kΩ	k to n		242	170	5 kΩ	80	4	0,51
	1 MΩ	k to n		354	250	25 kΩ	80	4	0,35
	2,2 MΩ	k to n		500	370	25 kΩ	80	4	0,24
semi logarithmic	470 Ω	o to r	1/3, 1/2 or 1/3 and 2/3	7,7	5,4	25 Ω	50	4	16
	1 kΩ	o to r		11	7,9	25 Ω	50	4	11
	2,2 kΩ	o to r		16	12	25 Ω	50	4	7,3
	4,7 kΩ	o to r		24	17	25 Ω	60	4	5,1
	10 kΩ	o to r		35	25	35 Ω	60	4	3,5
	22 kΩ	o to r		52	37	35 Ω	70	4	2,4
	47 kΩ	o to r		77	54	35 Ω **	70 **	4	1,6
	100 kΩ	o to r		112	79	50 Ω	80	4	1,1
	220 kΩ	o to r		166	117	100 Ω	80	4	0,73
	470 kΩ	o to r		242	170	250 Ω	80	4	0,51
	1 MΩ	o to r		354	250	500 Ω	80	4	0,35
	2,2 MΩ	o to r		500	370	1000 Ω	80	4	0,24
balance	10 kΩ	s	—	35	25	—	—	4	3,5
	22 kΩ	s	—	52	37	—	—	4	2,4
	47 kΩ	s	—	77	54	—	—	4	1,6
	100 kΩ	s	—	112	79	—	—	4	1,1
	220 kΩ	s	—	166	117	—	—	4	0,73
	470 kΩ	s	—	242	170	—	—	4	0,51
	1 MΩ	s	—	354	250	—	—	4	0,35
	2,2 MΩ	s	—	500	370	—	—	4	0,24

Notes: See previous page.

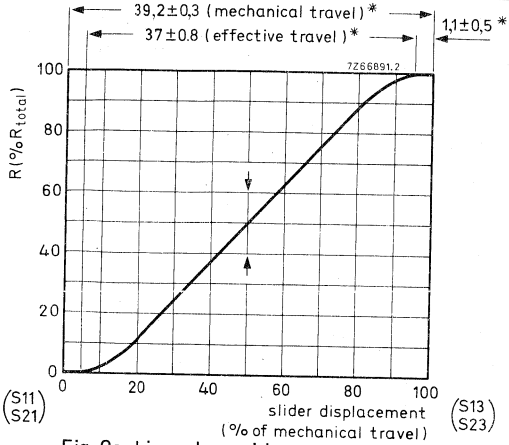


Fig. 9a Linear law; without tap.

*) Valid for all graphs.

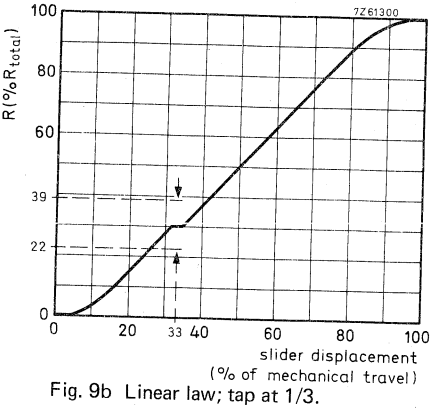


Fig. 9b Linear law; tap at 1/3.

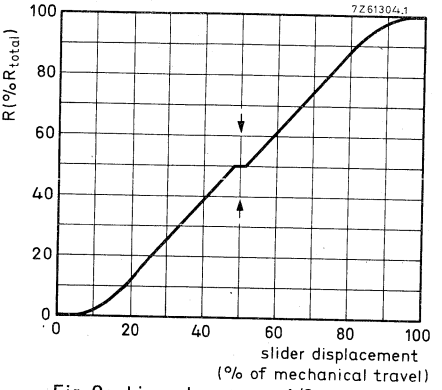


Fig. 9c Linear law; tap at 1/2.

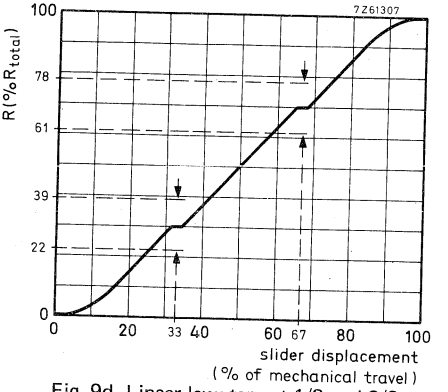


Fig. 9d Linear law; taps at 1/3 and 2/3.

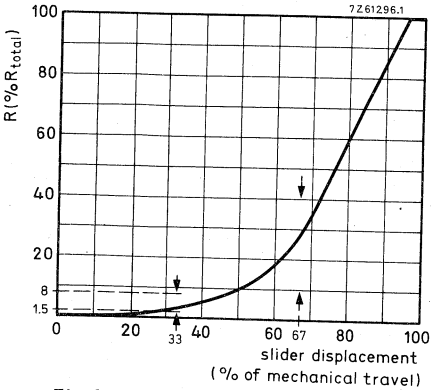


Fig. 9e Logarithmic law; without tap.

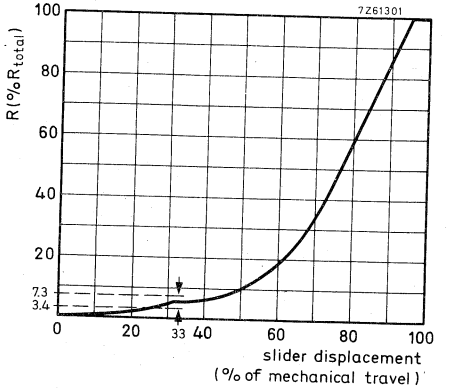


Fig. 9f Logarithmic law; tap at 1/3.

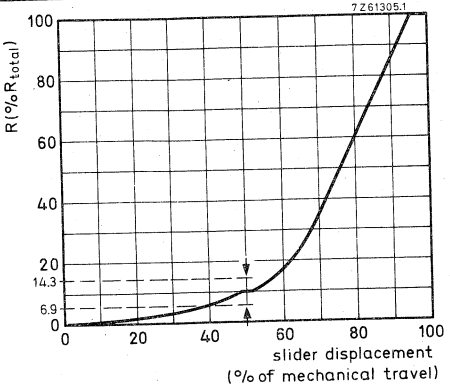


Fig. 9g Logarithmic law; tap at 1/2.

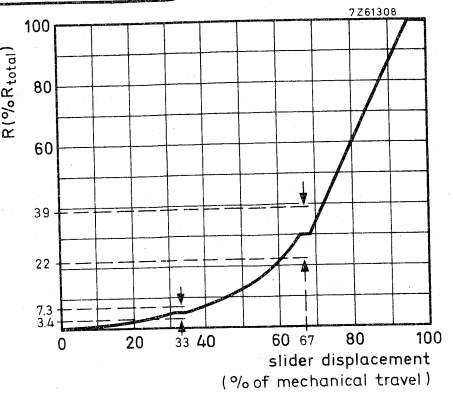


Fig. 9h Logarithmic law; taps at 1/3 and 2/3.

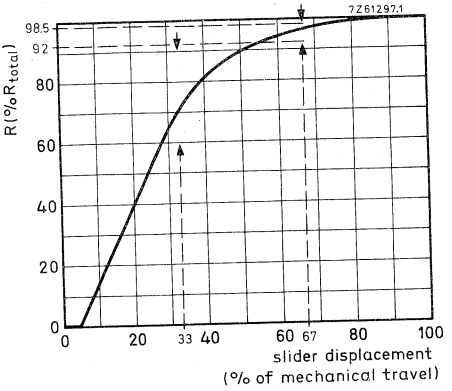


Fig. 9k Reversed logarithmic law, without tap.

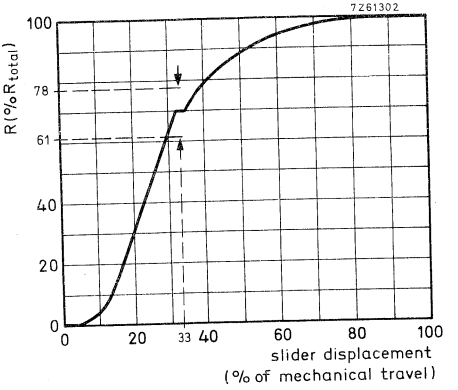


Fig. 9l Reversed logarithmic law; tap at 1/3.

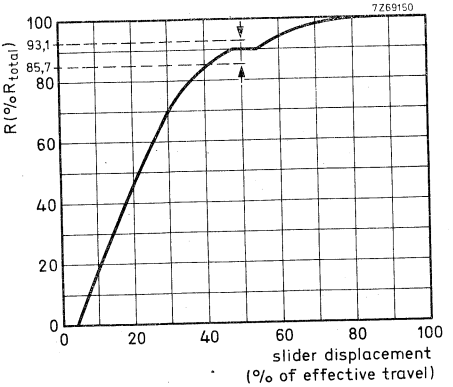


Fig. 9m Reversed logarithmic law; tap at 1/2.

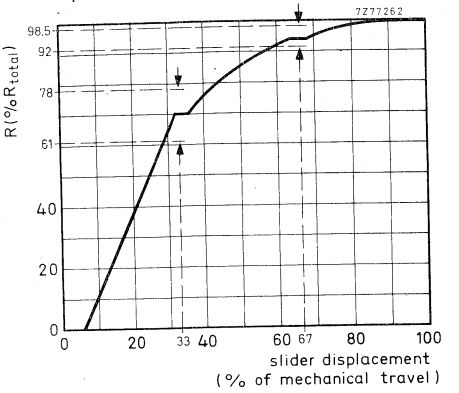


Fig. 9n Reversed logarithmic law; taps at 1/3 and 2/3.

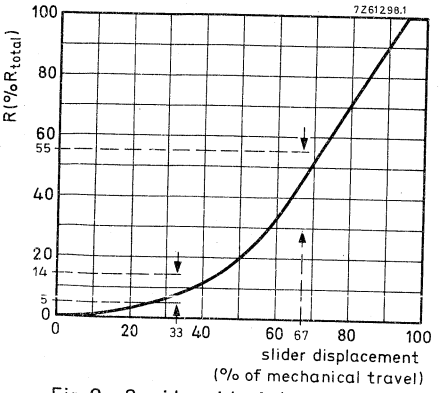


Fig. 9o Semi-logarithmic law; without tap.

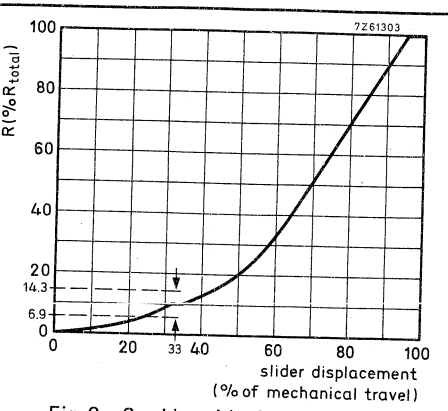


Fig. 9p Semi-logarithmic law; tap at 1/3.

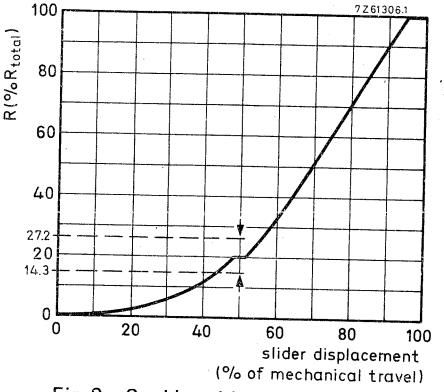


Fig. 9q Semi-logarithmic law; tap at 1/2.

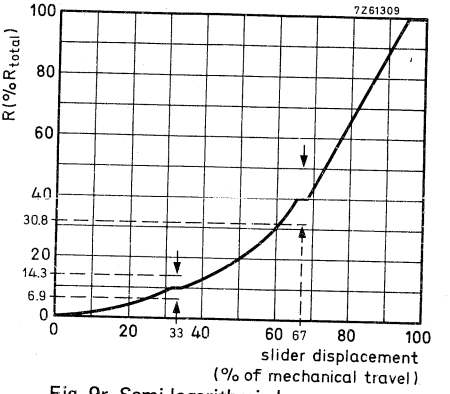


Fig. 9r Semi-logarithmic law; taps at 1/3 and 2/3.

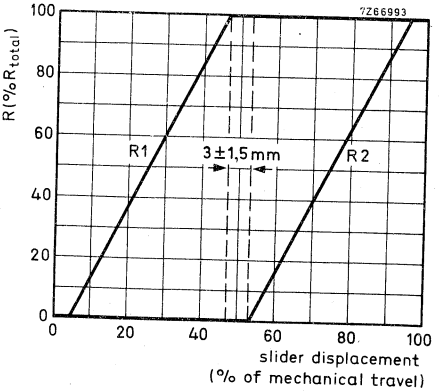


Fig. 9s Balance potentiometers.

Resistance law and tolerance	linear, logarithmic, reversed logarithmic, semi-logarithmic, balance, see Figs 9a to 9s
Tolerance on nominal resistance	± 20%
Minimum resistance at the tap	$\leqslant 10\ \Omega$
Insulation resistance (versions with external screening), initially	$> 10^4\ M\Omega$
Maximum dissipation (P_{max})	
linear law, at 40 °C	0,25 W
linear law, at 70 °C	0,125 W
logarithmic, reversed logarithmic and semi-logarithmic law, at 40 °C	0,125 W
semi-logarithmic law, at 70 °C	0,0625 W
Test voltage for 1 min (versions with external screening)	1000 V, 50 Hz
Working temperature range	−10 to +70 °C
Storage temperature range	−25 to +70 °C
Climatic category (IEC 68)	10/070/21
Operating force (F)	
single potentiometers	0,75 - 2 N; $\frac{F_{max}}{F_{min}} \leqslant 1,3$
tandem potentiometers	1,25 - 2,5 N; $\frac{F_{max}}{F_{min}} \leqslant 1,3$
Permissible force with slider at end stop *	$\leqslant 50$ N (Fig. 10a)
Permissible load perpendicular to the direction of movement *	$\leqslant 20$ N (Fig. 10b)
Permissible torque on slider *	$\leqslant 0,3$ Nm (Fig. 10c)
Permissible axial force on slider (push and pull) *	$\leqslant 50$ N

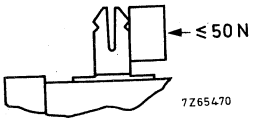


Fig. 10a.

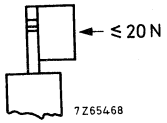


Fig. 10b.

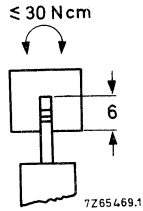


Fig. 10c.

* Measured for 5 s on a free slider without knob.

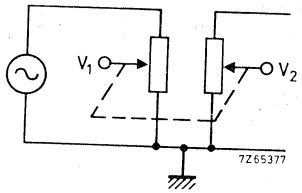
Effective travel of slider contact	37 ± 0,8 mm } see also Fig. 9a
Mechanical travel of slider contact	39,2 ± 0,3 }
Life	10 000 x in both directions
Ganging tolerance (tandem types only)	
linear law, without tap	
at values between 10 and 90% of R_{tot}	< 2 dB
linear law, with tap	< 3 dB
logarithmic, reversed logarithmic and semi-logarithmic law, without tap	
at attenuations between 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −40 dB	< 4 dB
logarithmic, reversed logarithmic and semi-logarithmic law, with tap	
at attenuations between 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −34 dB	< 4 dB

Note: Potentiometers with reversed logarithmic law are measured as those with logarithmic law.

Crosstalk * (measured according to Fig. 11).

	potentiometers with internal screening		potentiometers without internal screening	
resistance value	at 1 kHz	at 10 kHz	at 1 kHz	at 10 kHz
220 Ω to 100 kΩ	⩾ 70 dB	⩾ 55 dB	⩾ 60 dB	⩾ 45 dB
100 kΩ to 220 kΩ	⩾ 60 dB	⩾ 50 dB	⩾ 50 dB	⩾ 40 dB
220 kΩ to 470 kΩ	⩾ 60 dB	⩾ 50 dB	⩾ 50 dB	⩾ 40 dB
470 kΩ to 2,2 MΩ	⩾ 50 dB	⩾ 40 dB	⩾ 40 dB	⩾ 30 dB

Fig. 11 Crosstalk = 20 log $\frac{V_1}{V_2}$



Marking

The potentiometers are marked at the side with nominal resistance, resistance law, period and year of manufacture.

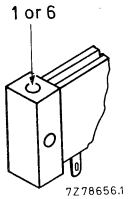
* For tandem potentiometers only.

AVAILABLE VERSIONS AND COMPOSITION OF THE CATALOGUE NUMBER

2322 43 . . . . .

code for type and screw-mounting facility

0 = without screw-mounting facility
1 = with screw-mounting facility
5 = without screw-mounting facility *
6 = with screw-mounting facility *



code for resistance law and nominal resistance, see table below

code for tap
0 = without tap
1 = tap at 1/3
2 = tap at 1/2
4 = taps at 1/3 and 2/3

code for screening and terminals

screening:	solder tags	p.w. pins
without	0	5
internal *	1	6
internal and external *	2	7
external	3	8

code for adjustment provision

0 = asymmetrically placed } length 12,5 mm
1 = symmetrically placed }

2 = asymmetrically placed } length 16 mm
3 = symmetrically placed }

Note

Detent slide potentiometers (11 click-, 21 click- and centre- click types) can be supplied on request.

nominal resistance	code in catalogue number				
	linear law	log. law	reversed log. law	semi-log. law	balance *
220 Ω	02			63	
470 Ω	03			64	
1 kΩ	04	24	44	65	
2,2 kΩ	05	25	45	66	
4,7 kΩ	06	26	46	67	87
10 kΩ	07	27	47	68	88
22 kΩ	08	28	48	69	89 only
47 kΩ	09	29	49	71	91 available
100 kΩ	11	31	51	72	92 without
220 kΩ	12	32	52	73	93 tap
470 kΩ	13	33	53	74	94
1 MΩ	14	34	54	75	95
2,2 MΩ	15	35	55		
4,7 MΩ	16				
330 Ω	19				

* For tandem potentiometers only.

60 mm SLIDE CARBON POTENTIOMETERS

QUICK REFERENCE DATA

Nominal resistance	
linear law	220 Ω – 10 MΩ
logarithmic, reversed logarithmic and semi-logarithmic law	1 kΩ – 4,7 MΩ
Maximum dissipation at 40 °C	
linear law	0,4 W
logarithmic, reversed logarithmic and semi-logarithmic law	0,2 W
Category (IEC68)	10/070/21

DESCRIPTION

This slide carbon potentiometer series includes two types:
– single potentiometers, for general purposes,
– tandem potentiometers, for stereophonic purposes.

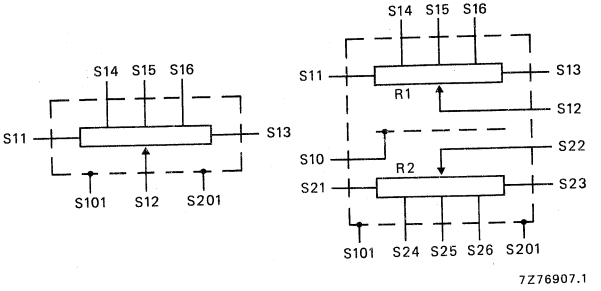
The single potentiometers have a straight carbon track on a resin bonded paper base plate mounted in a black synthetic resin housing.

The tandem potentiometers have two carbon tracks opposite each other on resin bonded paper base plates.

The terminals are connected as shown below. The potentiometers can be supplied without taps or with taps at 1/3 or 1/2 or 1/3 and 2/3 of the total travel.

Both types of potentiometer are available with or without metal screening on the outer surface of the housing to provide protection against interference. The tandem potentiometers can also be supplied with a metal screen between the two carbon tracks to prevent crosstalk.

The potentiometers are available with a variety of connecting terminals and adjustment provisions. Detent slide potentiometers (11 click, 31 click and centre click) can be supplied to special order.



Single type

Tandem type

Fig. 1 Terminal allocations.

MECHANICAL DATA

Dimensions in mm

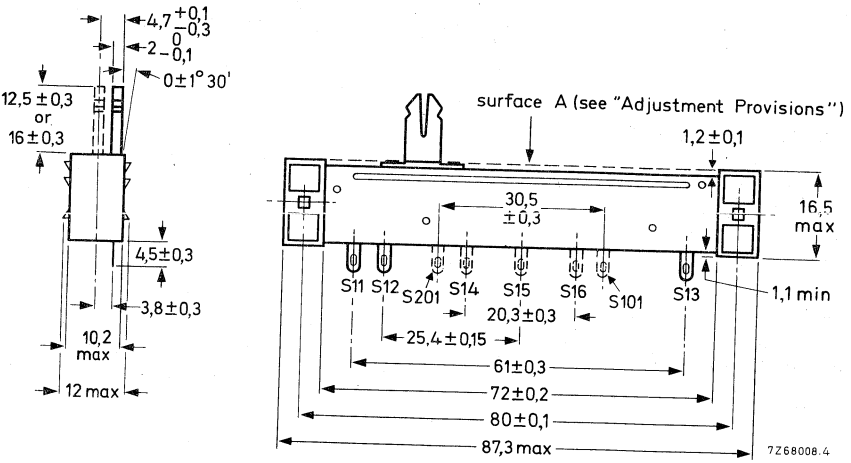


Fig. 2 Single slide potentiometer with solder tags.

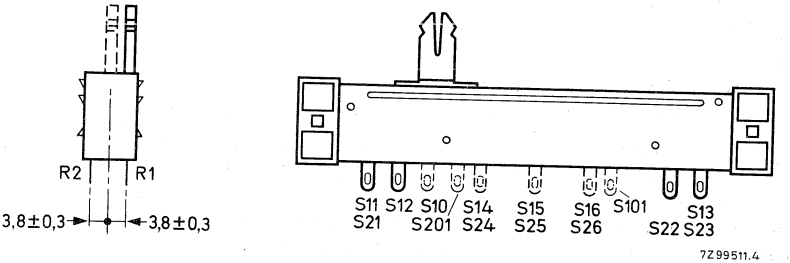


Fig. 3 Tandem slide potentiometer with solder tags.

Dimensions are identical with those in Fig. 2 except as shown.
The side on which potentiometer R1 is situated is indicated by a mark at the beginning of R1.

Mounting

Use two type 4N Parker self-tapping screws (according to UN-B1005 or UN-B1023, minimum thread length 8 mm) in the two holes spaced 80 mm apart.

Maximum tightening torque: 500 mNm. Minimum stripping torque: 700 mNm.

Connecting terminals

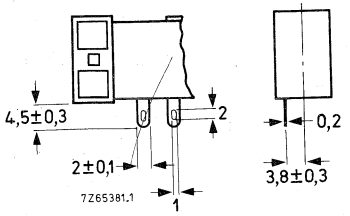


Fig. 4 Solder tags.

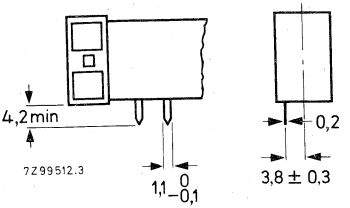


Fig. 5 Printed-wiring pins.

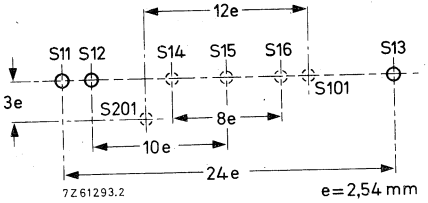


Fig. 6 Hole pattern in the printed-wiring board for a single potentiometer (viewed on component side).

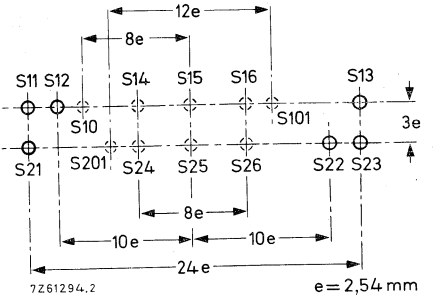


Fig. 7 Hole pattern in the printed-wiring board for a tandem potentiometer (viewed on component side).

Adjustment provisions

Four types of adjustment sliders are available:
- symmetrically positioned height 12,5 mm or 16 mm
- asymmetrically positioned height 12,5 mm or 16 mm

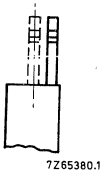


Fig. 8 End view of potentiometer with symmetrically (dotted lines) and asymmetrically positioned adjustment slider.

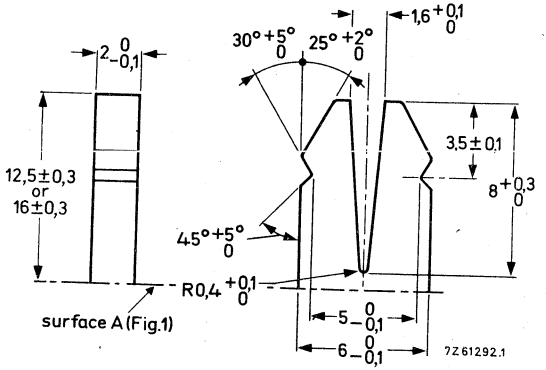


Fig. 9 Adjustment slider.

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 86 to 106 kPa and a relative humidity of 45 to 75%.

	nom. resist. R_n*	resist. law acc. to Fig. 10	tap at	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resist.	max. attenuation dB	max. contact resist. % R_n	limiting slider current at 40 °C mA
linear	220 Ω	a to d	1/3 or 1/2 or 1/3 and 2/3	9,3	7,4	10 Ω	–	3	40
	470 Ω	a to d		14	11	10 Ω	–	3	22
	1 kΩ	a to d		20	16	25 Ω	–	3	16
	2,2 kΩ	a to d		30	23	25 Ω	–	3	11
	4,7 kΩ	a to d		41	34	25 Ω	–	2	7
	10 kΩ	a to d		63	50	35 Ω	–	2	5
	22 kΩ	a to d		93	74	35 Ω	–	2	3,5
	47 kΩ	a to d		137	108	35 Ω	–	2	2,2
	100 kΩ	a to d		200	158	100 Ω	–	2	1,4
	220 kΩ	a to d		296	234	125 Ω	–	2	1,0
	470 kΩ	a to d		410	342	250 Ω	–	2	0,65
	1 MΩ	a to d		500	500	1 kΩ	–	2	0,45
	2,2 MΩ	a to d		500	500	2,2 kΩ	–	2	0,32
	4,7 MΩ	a to d		500	500	4,7 kΩ	–	2	0,22
	10 MΩ	a to d		500	500	10 kΩ	–	2	0,16
	330 Ω	a to d		11,5	9,1	10 Ω	–	3	30

* Measured between terminals S_{11} and S_{13} (or S_{21} and S_{23}).

	nom. resist. R_n*	resist law acc. to Fig. 10	tap at	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resist.		max. attenuation dB		max. contact resist. % R_n	limiting slider current at 40 °C mA
logarithmic	1 kΩ	e to h	1/3 or 1/2 or 1/3 and 2/3	14	11	25 Ω	**	50	**	4	10
	2,2 kΩ	e to h		21	16	25 Ω		60		4	7
	4,7 kΩ	e to h		31	24	25 Ω		60		4	4,5
	10 kΩ	e to h		45	35	35 Ω		60		4	3,2
	22 kΩ	e to h		66	52	35 Ω		70		4	2,2
	47 kΩ	e to h		97	77	35 Ω		70		4	1,4
	100 kΩ	e to h		141	112	50 Ω		80		4	1,0
	220 kΩ	e to h		210	166	50 Ω		80		4	0,7
	470 kΩ	e to h		310	242	100 Ω		80		4	0,45
	1 MΩ	e to h		447	354	500 Ω		80		4	0,32
	2,2 MΩ	e to h		500	500	500 Ω		80		4	0,22
	4,7 MΩ	e to h		500	500	1 kΩ		80		4	0,14
reversed logarithmic	1 kΩ	k, 1	1/3	14	11	100 Ω	**	50	***	4	10
	2,2 kΩ	k, 1		21	16	100 Ω		60		4	7
	4,7 kΩ	k, 1		31	24	100 Ω		60		4	4,5
	10 kΩ	k, 1		45	35	250 Ω		60		4	3,2
	22 kΩ	k, 1		66	52	250 Ω		70		4	2,2
	47 kΩ	k, 1		97	77	500 Ω		70		4	1,4
	100 kΩ	k, 1		141	112	2,5 kΩ		80		4	1,0
	220 kΩ	k, 1		210	166	2,5 kΩ		80		4	0,7
	470 kΩ	k, 1		310	242	5 kΩ		80		4	0,45
	1 MΩ	k, 1		447	354	25 kΩ		80		4	0,32
	2,2 MΩ	k, 1		500	500	25 kΩ		80		4	0,22
	4,7 MΩ	k, 1		500	500	50 kΩ		80		4	0,14
semi-logarithmic	470 Ω	m to p	1/3 or 1/2 or 1/3 and 2/3	9,7	7,7	10 Ω	**	40	**	5	14
	1 kΩ	m to p		14	11	25 Ω		50		4	10
	2,2 kΩ	m to p		21	16	25 Ω		50		4	7
	4,7 kΩ	m to p		31	24	25 Ω		60		4	4,5
	10 kΩ	m to p		45	35	35 Ω		60		4	3,2
	22 kΩ	m to p		66	52	35 Ω		70		4	2,2
	47 kΩ	m to p		97	77	35 Ω		70		4	1,1
	100 kΩ	m to p		141	112	50 Ω		80		4	1,0
	220 kΩ	m to p		210	166	100 Ω		80		4	0,7
	470 kΩ	m to p		310	242	250 Ω		80		4	0,45
	1 MΩ	m to p		447	354	500 Ω		80		4	0,32
	2,2 MΩ	m to p		500	500	1 kΩ		80		4	0,22
	4,7 MΩ	m to p		500	500	2,5 kΩ		80		4	0,14

* Measured between terminals S_{11} and S_{13} (or S_{21} and S_{23}).

** Measured between terminals S_{11} and S_{12} (or S_{21} and S_{22}); slider at the beginning of the travel.

*** Measured between terminals S_{13} and S_{12} (or S_{23} and S_{22}); slider at the end of the travel.

	nom. resist R_n**	resist law acc. to Fig. 10	tap at	max. voltage (V) at 40 °C	max. voltage (V) at 70 °C	max. terminal resist.	max. attenuation dB	max. contact resist. % R_n	limiting slider current at 40 °C mA
balance	10 kΩ	q	–	45	35	–	–	4	3,2
	22 kΩ	q	–	66	52	–	–	4	2,2
	47 kΩ	q	–	97	77	–	–	4	1,4
	100 kΩ	q	–	141	112	–	–	4	1,0
	220 kΩ	q	–	250	166	–	–	4	0,7
	470 kΩ	q	–	310	242	–	–	4	0,45
	1 MΩ	q	–	447	354	–	–	4	0,32
	2,2 MΩ	q	–	500	500	–	–	4	0,22
	4,7 MΩ	q	–	500	500	–	–	4	0,14

** Measured between terminals S_{11} and S_{13} (or S_{21} and S_{23}).

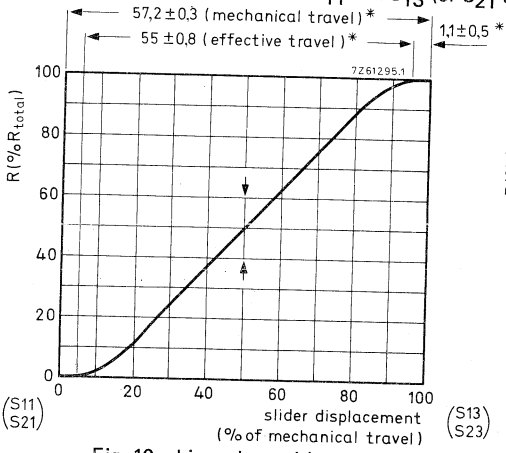


Fig. 10a Linear law; without tap.

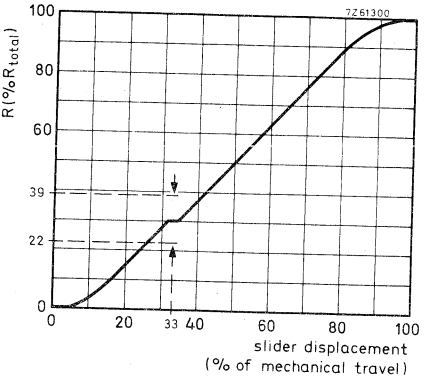


Fig. 10b Linear law; tap at 1/3.

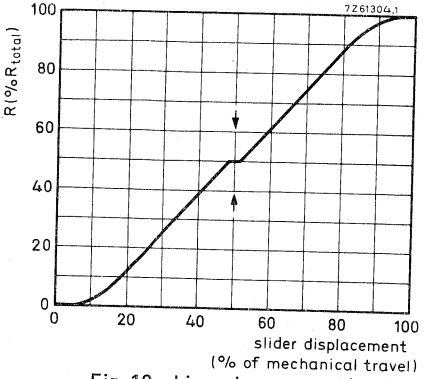


Fig. 10c Linear law; tap at 1/2.

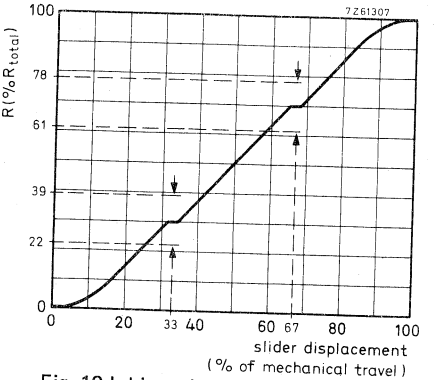


Fig. 10d Linear law; taps at 1/3 and 2/3.

* Valid for all graphs.

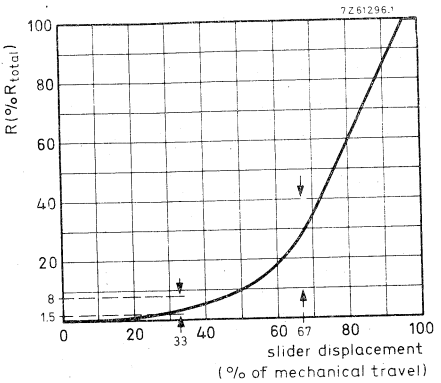


Fig. 10e Logarithmic law; without tap.

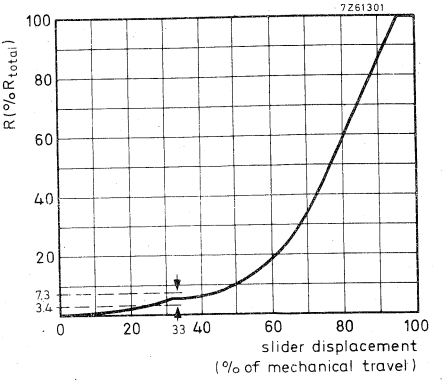


Fig. 10f Logarithmic law; tap at 1/3.

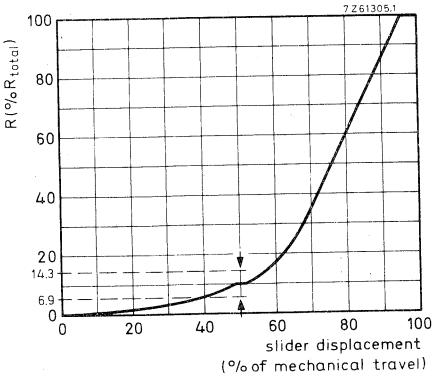


Fig. 10g Logarithmic law; tap at 1/2.

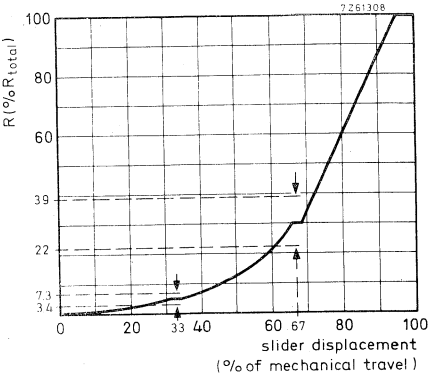


Fig. 10h Logarithmic law; taps at 1/3 and 2/3.

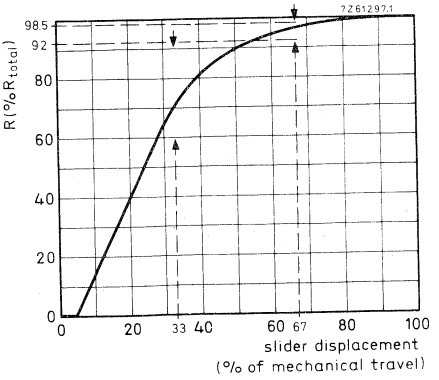


Fig. 10k Reversed logarithmic law; without tap.

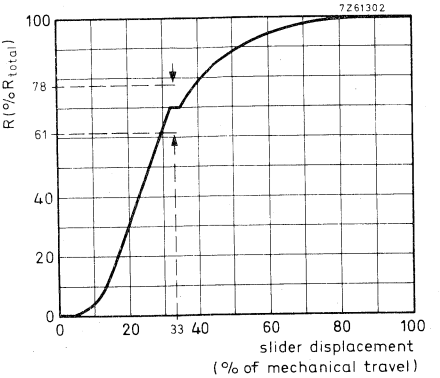


Fig. 10l Reversed logarithmic law; tap at 1/3.

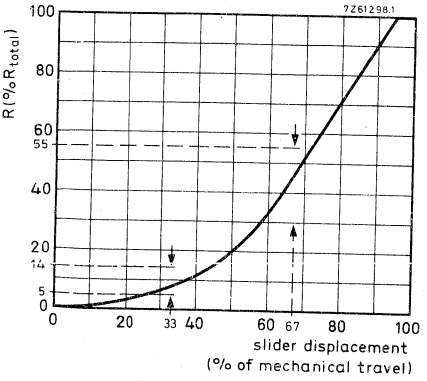


Fig. 10m Semi-logarithmic law; without tap.

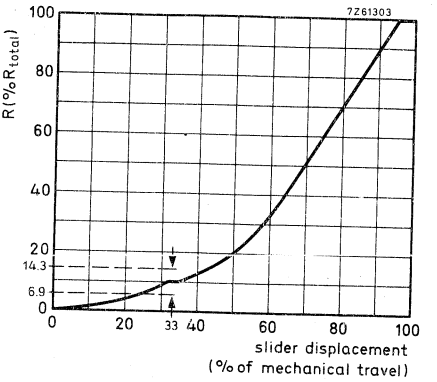


Fig. 10n Semi-logarithmic law; tap at 1/3.

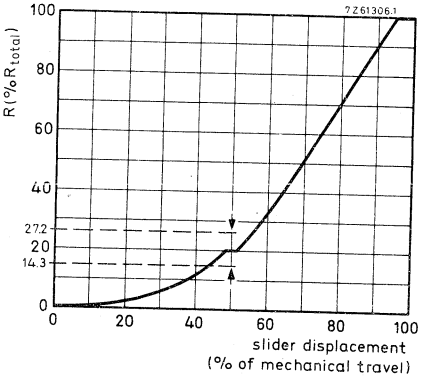


Fig. 10o Semi-logarithmic law; tap at 1/2.

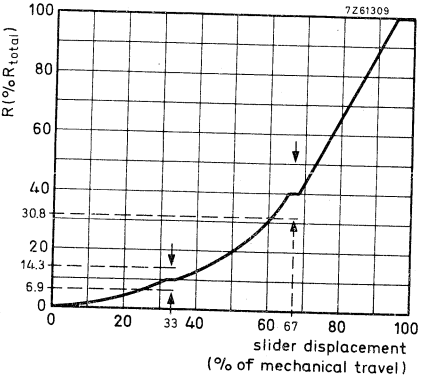


Fig. 10p Semi-logarithmic law; taps at 1/3 and 2/3.

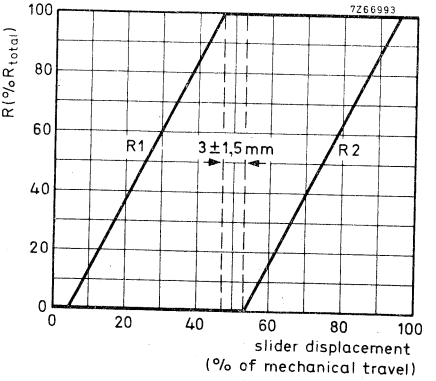


Fig. 10q Balance potentiometers.

Resistance law and tolerance	linear, logarithmic, reversed logarithmic, semi-logarithmic, balance, see Figs 10a to 10q
Tolerance on nominal resistance	± 20%
Minimum resistance between the slider and the tap(s) when aligned	⩽ 10 Ω
Insulation resistance (versions with external screening), initially	> 10^4 MΩ
Maximum dissipation (P_{max}) linear law, at 40 °C	0,4 W
at 70 °C	0,25 W
logarithmic, reversed logarithmic and semi-logarithmic law, at 40 °C	0,2 W
at 70 °C	0,125 W
Test voltage for 1 min	1000 V, 50 Hz
Working temperature range	−10 to + 70 °C
Storage temperature range	−25 to + 70 °C
Category (IEC68)	10/070/21
Operating force (F) single potentiometers	0,75 − 2 N 1,25 − 2,5 N $\frac{F_{max}}{F_{min}} \leqslant 1,5$
tandem potentiometers	⩽ 50 N (Fig. 11a)
Permissible force with slider at end stop*	⩽ 20 N (Fig. 11b)
Permissible load perpendicular to the direction of movement*	⩽ 0,3 Nm (Fig. 11c)
Permissible torque on slider*	⩽ 50 N
Permissible axial force on slider (push and pull)*	

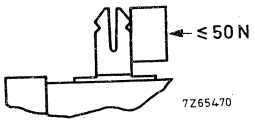


Fig. 11a.

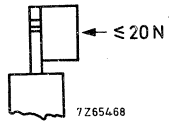


Fig. 11b.

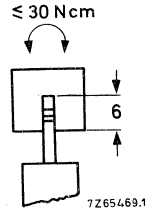


Fig. 11c.

Effective travel of slider contact	55 ± 0,8 mm 57,2 ± 0,3 mm see also Fig. 10a
Mechanical travel of slider contact	10 000 traverses in both directions
Life	

* Measured for 5 s on a free slider without knob.

Ganging tolerance*

Linear law, without tap, at values between 10 and 90% of R_{tot}	< 2 dB
Linear law, with tap, at values between 10 and 90% of R_{tot}	< 3 dB
Logarithmic, reversed logarithmic and semi-logarithmic law, without tap,	
at attenuations between − 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −40 dB	< 4 dB
Logarithmic, reversed logarithmic and semi-logarithmic law, with tap,	
at attenuations between 0 and −20 dB	< 2 dB
at attenuations between −20 and −30 dB	< 3 dB
at attenuations between −30 and −34 dB	< 4 dB

Crosstalk* (measured according to Fig. 12)

resistance value	potentiometers with internal screening		potentiometers without internal screening	
	at 1 kHz	at 10 kHz	at 1 kHz	at 10 kHz
220 Ω to 100 kΩ	⩽ −70 dB	⩽ −55 dB	⩽ −60 dB	⩽ −45 dB
100 kΩ to 220 kΩ	⩽ −60 dB	⩽ −50 dB	⩽ −50 dB	⩽ −40 dB
220 kΩ to 470 kΩ	⩽ −60 dB	⩽ −50 dB	⩽ −50 dB	⩽ −40 dB
470 kΩ to 2,2 MΩ	⩽ −50 dB	⩽ −40 dB	⩽ −40 dB	⩽ −30 dB

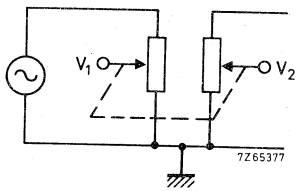


Fig. 12 Crosstalk = $20 \log \frac{V_2}{V_1}$.

MARKING

The side of the potentiometers is marked with nominal resistance, resistance law, period and year of manufacture.

* For tandem potentiometers only.

AVAILABLE VERSIONS AND COMPOSITION OF THE CATALOGUE NUMBER

2322 42. . . . . .

code for type

4 = single potentiometer
9 = tandem potentiometer

code for resistance law and nominal resistance, see table below

code for taps
0 = without taps
1 = tap at 1/3
2 = tap at 1/2
4 = taps at 1/3 and 2/3

code for screening and terminals

screening:	solder tags	p.w. pins
without	0	5
internal*	1	6
internal and external*	2	7
external	3	8

code for adjustment provision

0 = asymmetrically, 1 = symmetrically — length 12,5 mm

2 = asymmetrically, 3 = symmetrically — length 16 mm

Note: Detent slide potentiometers (11 click, 31 click and centre click types) can be supplied to special order.

nominal resistance	code in catalogue number				
	linear law	log. law	reversed log. law	semi-log. law	balance
220 Ω	02			63	
470 Ω	03			64	
1 kΩ	04	24	44	65	
2,2 kΩ	05	25	45	66	
4,7 kΩ	06	26	46	67	87
10 kΩ	07	27	47	68	88
22 kΩ	08	28	48	69	89
47 kΩ	09	29	49 **	71	91
100 kΩ	11	31	51	72	92 ***
220 kΩ	12	32	52	73	93
470 kΩ	13	33	53	74	94
1 MΩ	14	34	54	75	95
2,2 MΩ	15	35	55	76	96
4,7 MΩ	16	36	56		
10 MΩ	17				
330 Ω	19				

* For tandem potentiometers only.
** Only available without tap and with tap at 1/3 of total travel.
*** Only available without tap.

POTPACK CARBON CONTROL POTENTIOMETERS

single and tandem version

QUICK REFERENCE DATA

Resistance range (E3-series)	
linear law	22 Ω to 4,7 MΩ
logarithmic law	1 kΩ to 2,2 MΩ
Maximum dissipation at T_{amb} = 40 °C	
linear law	0,2 W
logarithmic law	0,1 W
Climatic category (IEC 68)	25/070/10

DESCRIPTION

The potpack carbon control potentiometer series includes: single and tandem types, which are available with a logarithmic or linear resistance law, without or with s.p.s.t. switch.

Possible combinations

terminals	in line		staggered	
switch	no	yes	no	yes
no taps	●	●	●	–
lin/log, one tap	–	–	●	●
rev. log, one tap	–	–	●	●
two taps	–	–	●	●

The potentiometers have a carbon track on a phenolic paper base fixed in a plastic housing. The metallic slider has a double contact and is mounted on a plastic rotor. Terminals a and c are connected to the ends of the carbon track. Terminal b is connected via a contact ring to the slider. If the potentiometers have taps, the outer terminals are connections d1, d2. The designation of terminals in according to IEC 393-1, subclause 4.5, see Fig. 1.

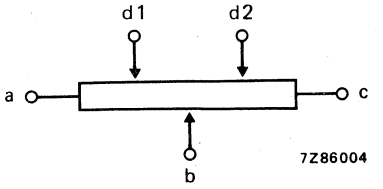


Fig. 1 The terminal pitch is 2,54 mm. See "Hole patterns".

Tandem-potentiometers comprise two ganged potentiometers with closely matched resistance tracks.

Both types of potentiometer can be supplied with either a metal or plastic spindle.

The rotor may have 41 or 11 detents equally spaced over the angle of rotation (300°), or one detent at mid-travel.

Any mechanical forces such as end stop torque and axial or radial external forces on the spindle are not transmitted to the carbon track.

Types

For dimensions d, L and L_1, see under Spindles.

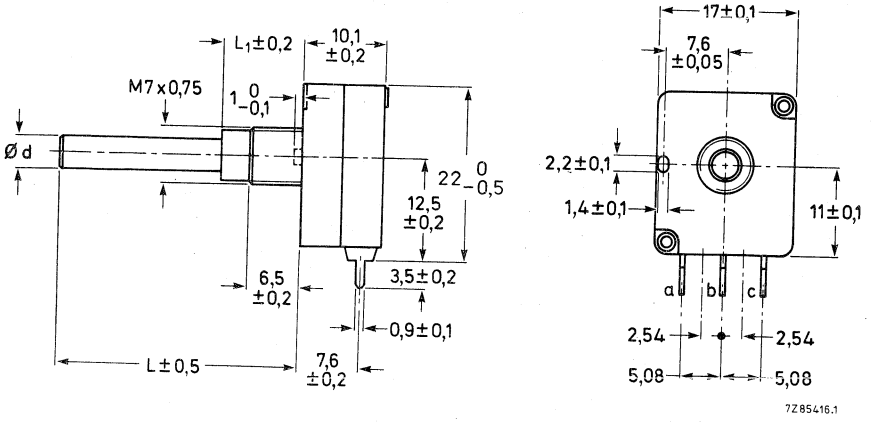


Fig. 2 Single potentiometer with mounting bush M7 x 0,75 mm.

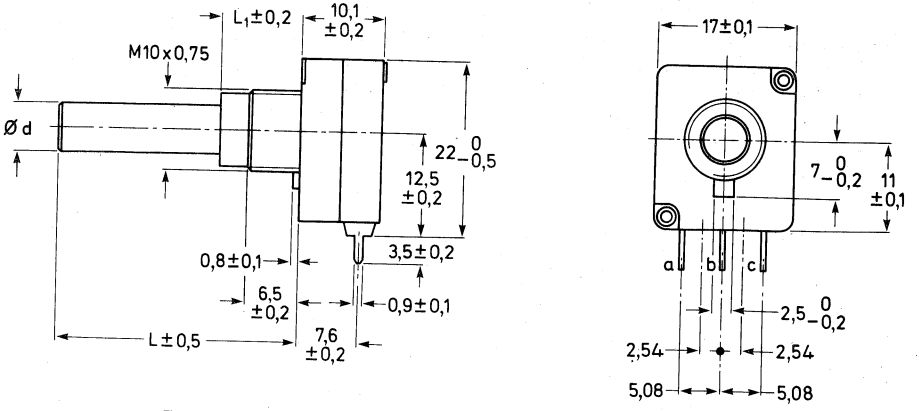


Fig. 3 Single potentiometer with mounting bush M10 x 0,75 mm.

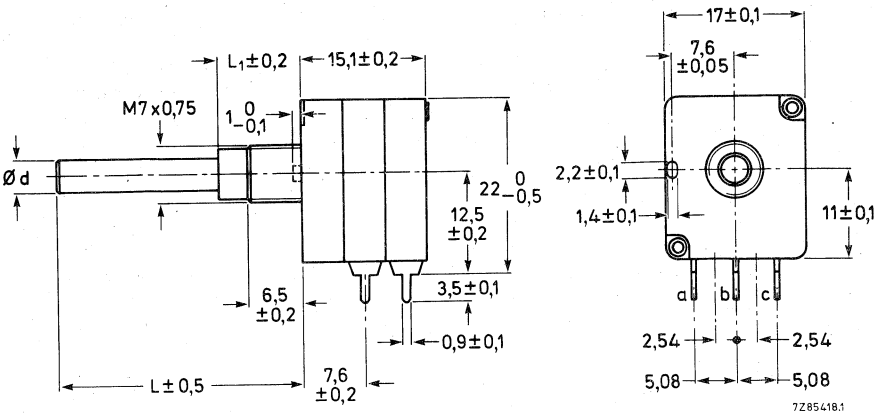


Fig. 4 Tandem potentiometer with mounting bush M7 x 0,75 mm.

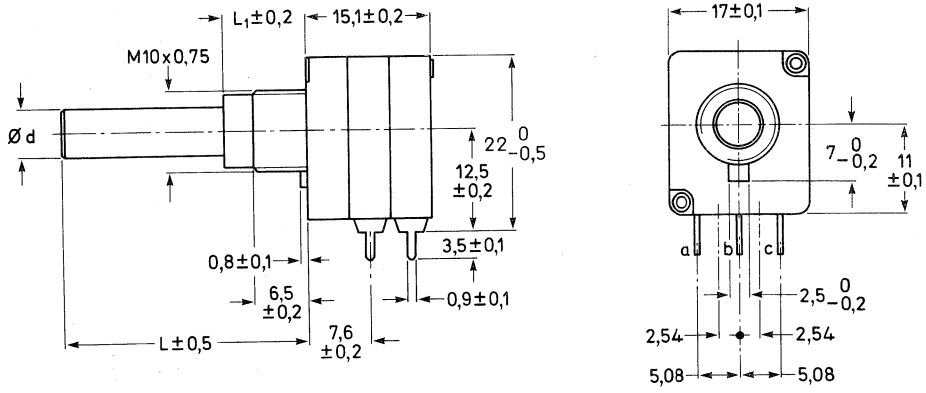


Fig. 5 Tandem potentiometer with mounting bush M10 x 0,75 mm.

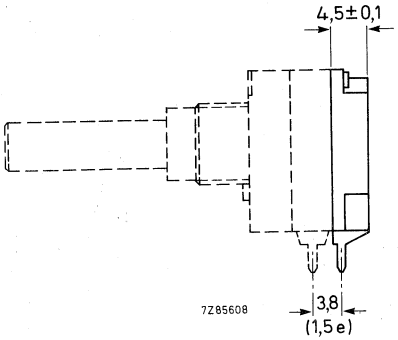
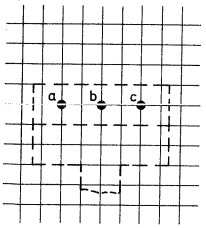
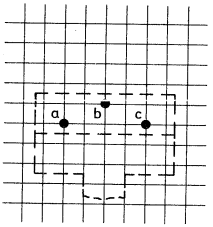
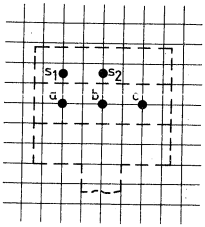
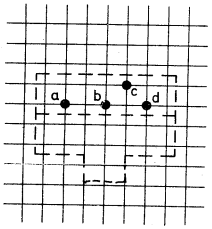
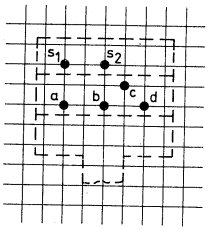
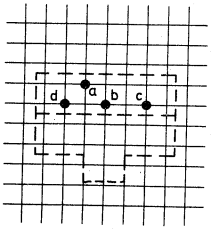
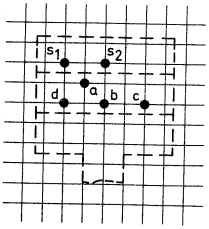
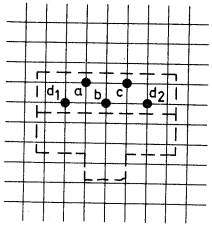
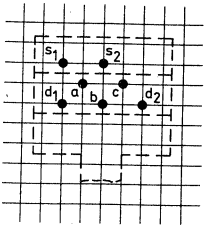
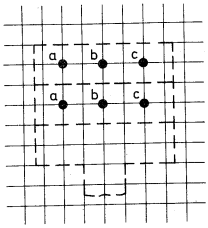
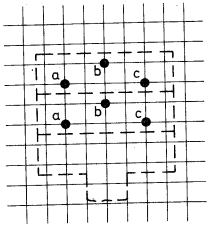
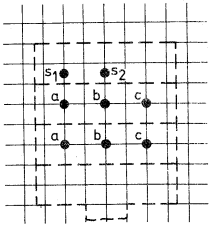
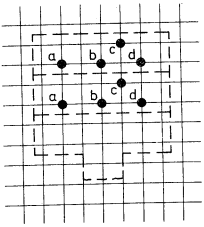
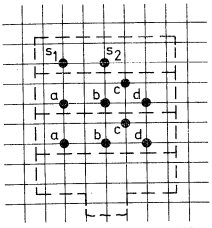
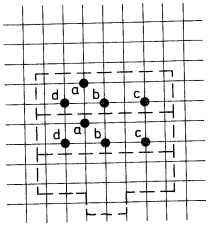
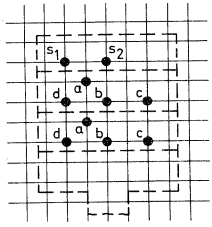
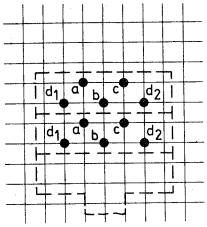
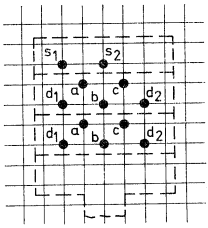


Fig. 6 Switch.

Hole patterns for connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side.

	without switch		with switch
	terminals in line	staggered terminals	
single, without tap Fig. 7a.			 7Z85430.1
single, lin or log, with one tap Fig. 7b.			 7Z85431.1
single neg. log, with one tap Fig. 7c.			 7Z85606
single, with 2 taps Fig. 7d.			 7Z85432.1

	without switch		with switch
	terminals in line	staggered terminals	
Tandem, without tap Fig. 7e.			 7Z85433.1
tandem, lin or log, with one tap Fig. 7f.			 7Z85435.1
tandem, neg. log, with one tap Fig. 7g.			 7Z85607
tandem, with two taps Fig. 7h.			 7Z85434.1

Spindles, metal or plastic, M7 bushing

CCW position

L mm	L_1 mm	L_2 mm	d metal	d plastic
15	8 and 12		4h9	$4_{-0,1}^{0}$
20	8 and 12		4h9	$4_{-0,1}^{0}$
25	8 and 12		4h9	$4_{-0,1}^{0}$
30	8 and 12		4h9	$4_{-0,1}^{0}$

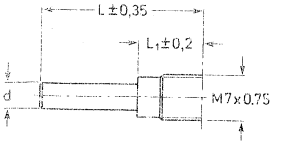
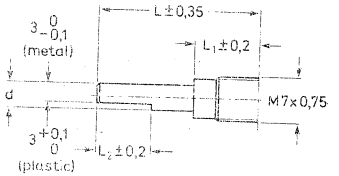


Fig. 10a

L mm	L_1 mm	L_2 mm	d metal	d plastic
15	8 and 12	3,0	4h9	$4_{-0,1}^{0}$
20	8 and 12	7,5	4h9	$4_{-0,1}^{0}$
25	8 and 12	8,5	4h9	$4_{-0,1}^{0}$
30	8 and 12	8,5	4h9	$4_{-0,1}^{0}$



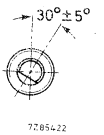
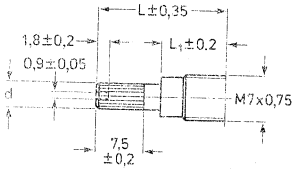


Fig. 10b

L mm	L_1 mm	d metal	d plastic
20	8 and 12		$4_{-0,1}^{0}$



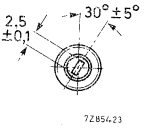
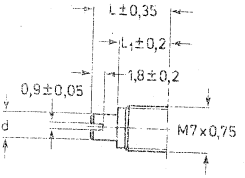


Fig. 10c

L mm	L_1 mm	d metal	d plastic
12	8	4h9	$4_{-0,1}^{0}$



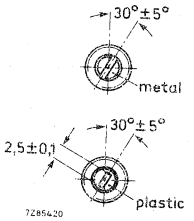


Fig. 10d

Spindles, metal or plastic, M10 bushing

CCW position

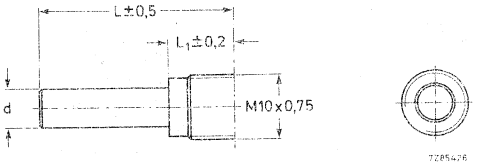


Fig. 11a

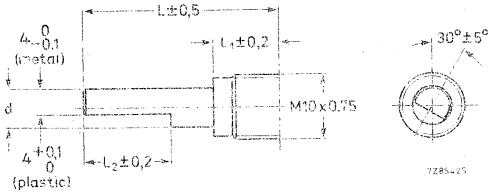


Fig. 11b

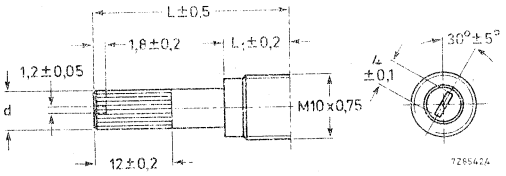


Fig. 11c

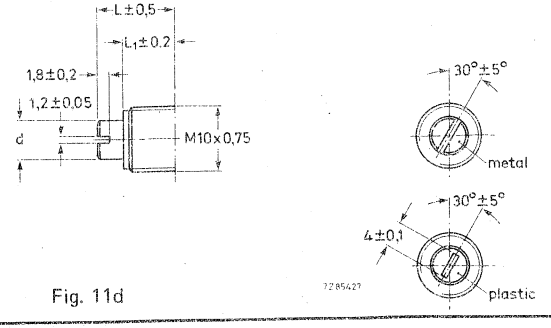
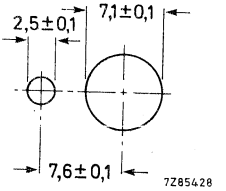
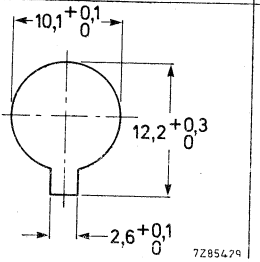


Fig. 11d

L mm	L_1 mm	L_2 mm	d metal	d plastic
20	8 and 12		6h9	$6_{-0,1}^{0}$
30	8 and 12		6h9	$6_{-0,1}^{0}$
40	8 and 12		6h9	$6_{-0,1}^{0}$
60	8 and 12		6h9	$6_{-0,1}^{0}$
90	8 and 12		6h9	$6_{-0,1}^{0}$
20	8 and 12	7,5	6h9	$6_{-0,1}^{0}$
30	8 and 12	13,5	6h9	$6_{-0,1}^{0}$
60	8 and 12	13,5	6h9	$6_{-0,1}^{0}$
30	8 and 12			$6_{-0,1}^{0}$
12	8		6h9	$6_{-0,1}^{0}$

Mounting facilities

for single and tandem potentiometers	required mounting holes in chassis	fixing of potentiometer
with mounting bush M7 x 0,75 mm	 Fig. 8.	with supplied mounting nut; max. torque for tightening = 1 Nm; min. thickness of chassis = 1 mm
with mounting bush M10 x 0,75 mm	 Fig. 9.	with supplied mounting nut; max. torque for tightening = 3,5 Nm; min. thickness of chassis = 1 mm

DEVELOPMENT SAMPLE DATA

TECHNICAL DATA

Unless otherwise specified, all values are valid at an ambient temperature of 18 to 22 °C, an atmospheric pressure of 860 to 1060 mbar and a relative humidity of 45 to 75%

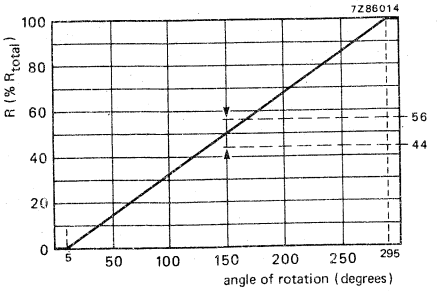
For measuring methods, see IEC publications 393-1 and 68. The terms used are explained in the Glossary of terms.

nominal resistance R_n	resistance law according to Fig. 12 type	limiting element voltage V (d.c.)		limiting slider current mA	
		at 40 °C	at 70 °C	at 40 °C	at 70 °C
22 Ω	A	2	1,4	95	67
47 Ω		3	2	65	46
100 Ω		4,4	3	44	31
220 Ω		6,6	4,7	30	21
470 Ω		9	6	20	14
1 kΩ		14	10	14	10
2,2 kΩ		21	14	9,5	6,7
4,7 kΩ		30	21	6,5	4,6
10 kΩ		44	31	4,5	3,2
22 kΩ		66	47	3	2,1
47 kΩ		97	68	2,0	1,5
100 kΩ		141	100	1,4	1
220 kΩ		210	148	1	0,7
470 kΩ		306	216	0,7	0,5
1 MΩ		447	316	0,4	0,3
2,2 MΩ		500	469	0,3	0,2
4,7 MΩ		500	500	0,2	0,1
1 kΩ	X, C, R, H, S, J, T, K or U	10	7	10	7
2,2 kΩ		14	10	6,7	4,8
4,7 kΩ		21	15	4,6	3,3
10 kΩ		31	22	3,2	2,2
22 kΩ		47	33	2,1	1,5
47 kΩ		68	48	1,5	1
100 kΩ		100	70	1	0,7
220 kΩ		148	104	0,7	0,5
470 kΩ		216	153	0,5	0,3
1 MΩ		316	223	0,3	0,2
2,2 MΩ		469	331	0,2	0,15

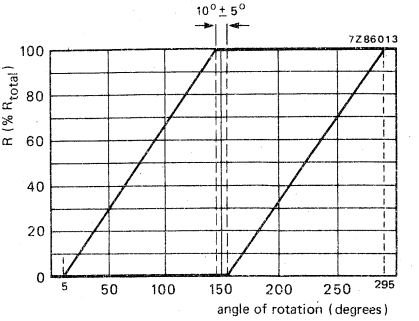
Tolerance on the nominal resistance	± 20% *
Resistance law and tolerances	see Fig. 12
Ganging tolerance (tandem potentiometers)	
linear law	
at values between 10 and 90% of R_{total}	< 2 dB
(reversed) logarithmic law	
at attenuations between 0 and 20 dB	< 2 dB
at attenuations between 20 and 40 dB	< 3 dB
at attenuations between 30 and 60 dB	< 4 dB
with a tap at 10% of R_{total}, tap load 1% of R_{total}	
at attenuations between 0 and 20 dB	< 2 dB
at attenuations between 20 and 40 dB	< 3 dB
at attenuations between 30 and 60 dB	< 4 dB
at attenuations between 60 and 70 dB	< 6 dB
at attenuations between 70 and 80 dB	< 7 dB
Minimum effective resistance	⩽ 2% of R_n
Minimum resistance at the tap	⩽ 1,5% of R_n
Contact resistance moving, initially	
linear law	⩽ 2,5% of R_{ac}
logarithmic law	⩽ 5% of R_{ac}
Contact resistance variation (CRV), initially (acc. to IEC 393-1, sub. clause 4.17)	
linear law	⩽ 1,5%
logarithmic law	⩽ 2,5%
Temperature coefficient of resistance	± 500. 10^{-6}/K
Insulation resistance after damp heat test (IEC 68, test C, 21 days)	> 100 MΩ
Maximum dissipation at T_{amb} = 40 °C (P_{max})	
linear law	0,2 W
logarithmic law	0,1 W derating see Fig. 13
Test voltage for 1 minute	1000 V, 50 Hz
Working temperature range	−25 to + 70 °C
Storage temperature range	−55 to + 100 °C
Climatic category (IEC 68)	25/070/10
Operating torque	5 to 20 mNm
Permissible end stop torque	⩽ 800 mNm
Angle of rotation	300 ± 2°
Effective angle of rotation	290 ± 2,5°

* For potentiometers with a tap the tolerance on R_{ad} as well as on R_{dc} = ± 20%

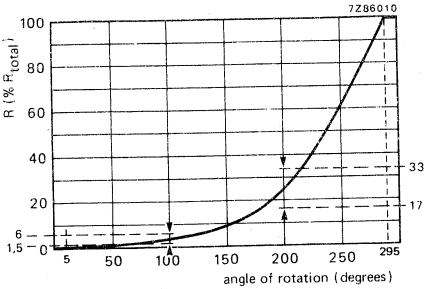
Characteristics of potentiometers without switch



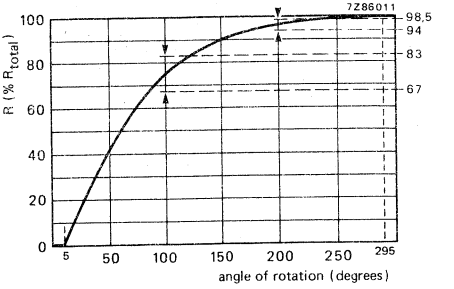
Type A
Fig. 12a Linear law.



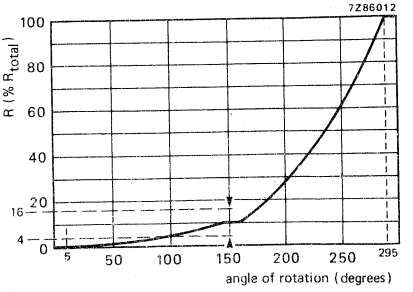
Type X
Fig. 12b Linear law.
Balance tandem potentiometers only.



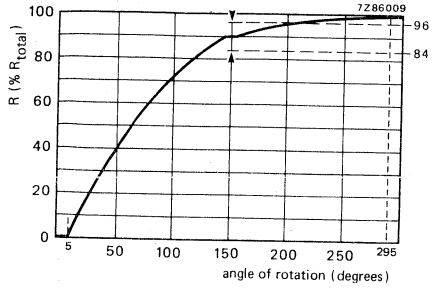
Type C
Fig. 12c Logarithmic law.



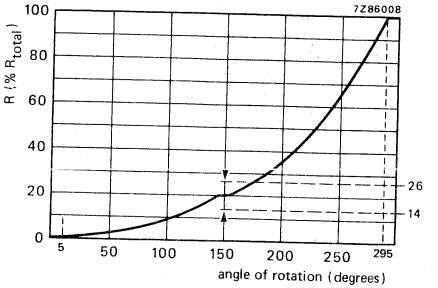
Type R
Fig. 12d Reversed logarithmic law.



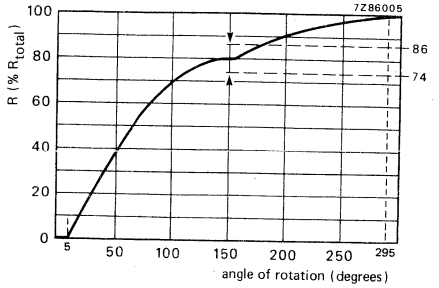
Type H
Fig. 12e Logarithmic law,
tap at 10%.



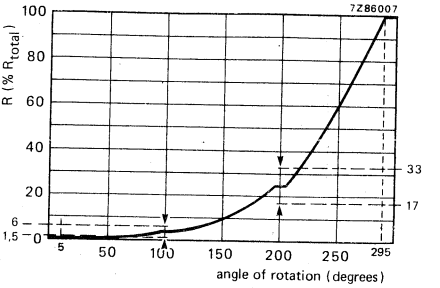
Type S
Fig. 12f Reversed logarithmic law, tap at 90%.



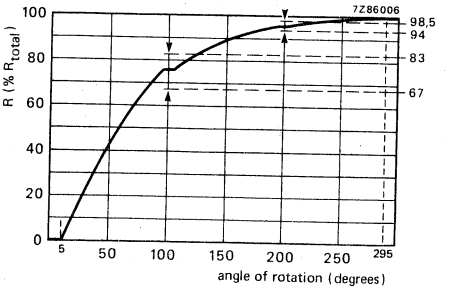
Type J
Fig. 12g Logarithmic law, tap at 20%.



Type T
Fig. 12h Reversed logarithmic law, tap at 80%.



Type K
Fig. 12j Logarithmic law, taps at 1/3 and 2/3.



Type U
Fig. 12k Reversed logarithmic law, taps at 1/3 and 2/3.

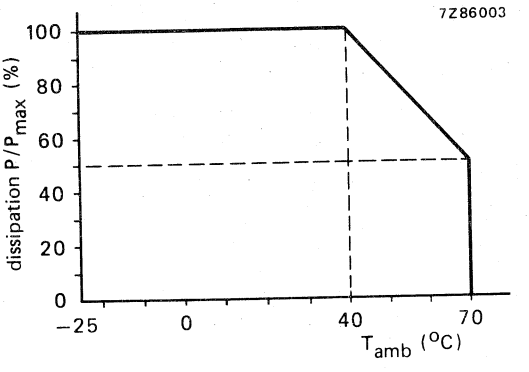


Fig. 13 Maximum permissible dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked with:

- nominal resistance (in RKM code acc. to IEC 62)
- resistance law
- code for period and year of manufacture.

COMPOSITION OF THE PART NUMBER

22PP50 . . . . . .

code for number of sections
1 single potmeter
2 tandem potmeters

0 = without switch 1 = with s.p.s.t. switch

mounting facility						
spindle length in mm ↓		M10 bushing		M7		
		length (mm)				
		8	12	8	12	
spindle diameter →		ϕ 6 mm		ϕ 4 mm		
plastic	**plastic**					
12, slot	12, slot	AB		FB		
15, plain	20, plain	AC	BC	FC	GC	
20, plain	30, plain	AD	BD	FD	GD	
25, plain	40, plain	AE	BE	FE	GE	
30, plain	60, plain	AF	BF	FF	GF	
15, flat	90, plain	AG	BG	FG	GG	
20, flat	20, flat	AH	BH	FH	GH	
25, flat	30, flat	AJ	BJ	FJ	GJ	
30, flat	60, flat	AK	BK	FK	GK	
20, knurl	30 knurl	AY	BY	FL	GL	
metal	**metal**					
12, slot	12, slot	AP		FP		
15, plain	20, plain	AQ	BQ	FQ	GQ	
20, plain	30, plain	AR	BR	FR	GR	
25, plain	40, plain	AS	BS	FS	GS	
30, plain	60, plain	AT	BT	FT	GT	
15, flat	90, plain	AU	BU	FU	GU	
20, flat	20, flat	AV	BV	FV	GV	
25, flat	30, flat	AW	BW	FW	GW	
30, flat	60, flat	AX	BX	FX	GX	

code for terminal configuration
A = in line
B = staggered

code for detents
0 = 0 detents
1 = 1 detent
2 = 11 detents
3 = 41 detents

code for resistance law
A = linear
C = logarithmic
R = reversed logarithmic
H = logarithmic tap at 10%
S = reversed log., tap at 90%
J = logarithmic, tap at 1/3 and 2/3
T = reversed log., tap at 1/3 and 2/3
K = logarithmic, tap at 1/3 and 2/3
U = reversed log., tap at 1/3 and 2/3
X = linear balance

code for resistance value	
05 = 22	Ω
09 = 47	Ω
14 = 100	Ω
18 = 220	Ω
23 = 470	Ω
27 = 1	kΩ
32 = 2,2	kΩ
36 = 4,7	kΩ
41 = 10	kΩ
45 = 22	kΩ
49 = 47	kΩ
54 = 100	kΩ
58 = 220	kΩ
63 = 470	kΩ
67 = 1	MΩ
72 = 2,2	MΩ
76 = 4,7	MΩ

CONVERSION LIST CATALOGUE NUMBER/PART NUMBER

catalogue number	part number
2322 501 02103	22PP501 0FF A0 A23
02104	A27
02105	A32
02106	A36
02107	A41
02108	A45
02109	A49
02111	A54
02112	A58
02113	A63
02114	A67
2322 501 02126	22PP501 0FF A0 C36
02127	C41
02128	C45
02129	C49
02131	C54
02132	C58
02133	C63
02134	C67
2322 502 02103	22PP502 0FF A0 A23
02104	A27
02105	A32
02106	A36
02107	A41
02108	A45
02109	A49
02111	A54
02112	A58
02113	A63
02114	A67
2322 502 02126	22PP502 0FF A0 C36
02127	C41
02128	C45
02129	C49
02131	C54
02132	C58
02133	C63
02134	C67
2322 501 90001	22PP501 0AE A0 A23
90002	A27
90003	A32
90004	A36
90005	A41
2322 501 90006	22PP501 0AE A0 A45
90007	A49
90008	A54
90009	A58
90011	A63
90012	A67
2322 501 90013	22PP501 0AE A0 C36
90014	C41
90015	C45
90016	C49
90017	C54
90018	C58
90019	C63
90021	C67

DEVELOPMENT SAMPLE DATA

MODULE CARBON CONTROL POTENTIOMETERS

horizontal and vertical version

QUICK REFERENCE DATA

Resistance range (E3 series)	
linear law	22 Ω to 4,7 MΩ
logarithmic law	1 kΩ to 2,2 MΩ
Maximum dissipation at T_{amb} = 40 °C	
linear law	0,2 W
logarithmic law	0,1 W
Climatic category (IEC 68)	25/070/10

DESCRIPTION

A series of single, modular control potentiometers comprising versions for horizontal or vertical mounting on p.w. boards. Both versions are available with a logarithmic or linear resistance law. The modules have a carbon track on a phenolic paper base fixed in a plastic housing. The metallic slider has a double contact and is mounted on a plastic rotor. The modules have no spindle but have either a flat or a protruding rotor. The rotor is slotted to accept a driving spindle. The *vertical versions* can be supplied with or without mounting bracket. Vertical modules with a flat rotor can be combined, and are available with or without s.p.s.t. switch. The rotor has optionally no detents or one detent at mid-travel.

Terminals a and c are connected to the ends of the carbon track. Terminal b is connected via a contact ring to the slider. If the modules have taps, the outer terminals are connections d1, d2.

The designation of terminals is according to IEC 393-2, subclause 4.5, see Fig. 1.

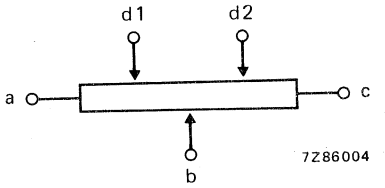


Fig. 1.

The terminal pitch is 2,54 mm. See "hole patterns".

Modular tandem-potentiometers, series PP17MT are described in a separate data sheet.

Types

Horizontal versions, rotor drawn at fully counter-clockwise position (starting position)

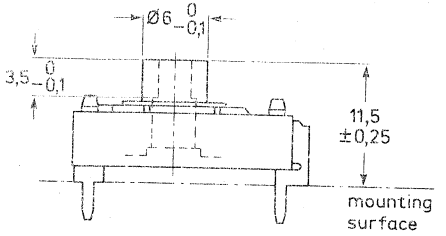


Fig. 2a With protruding rotor.

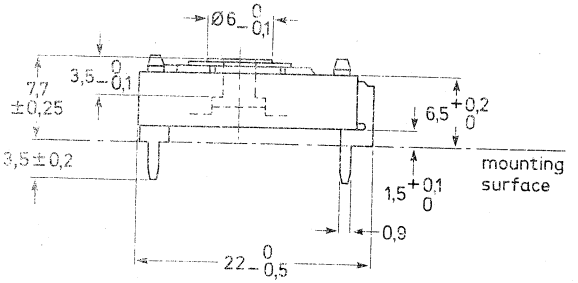
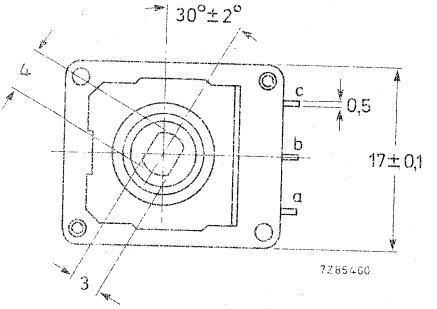


Fig. 2b With flat rotor.



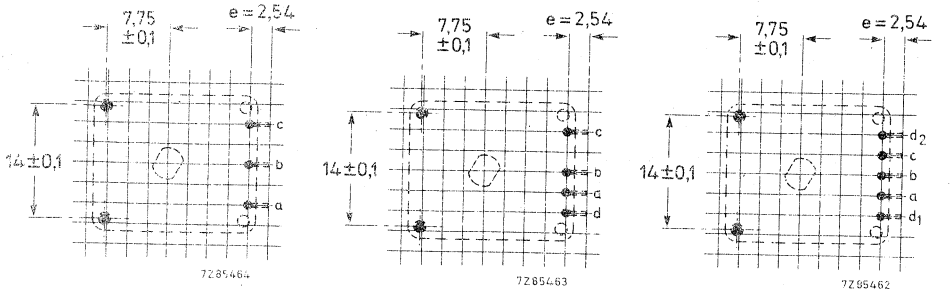
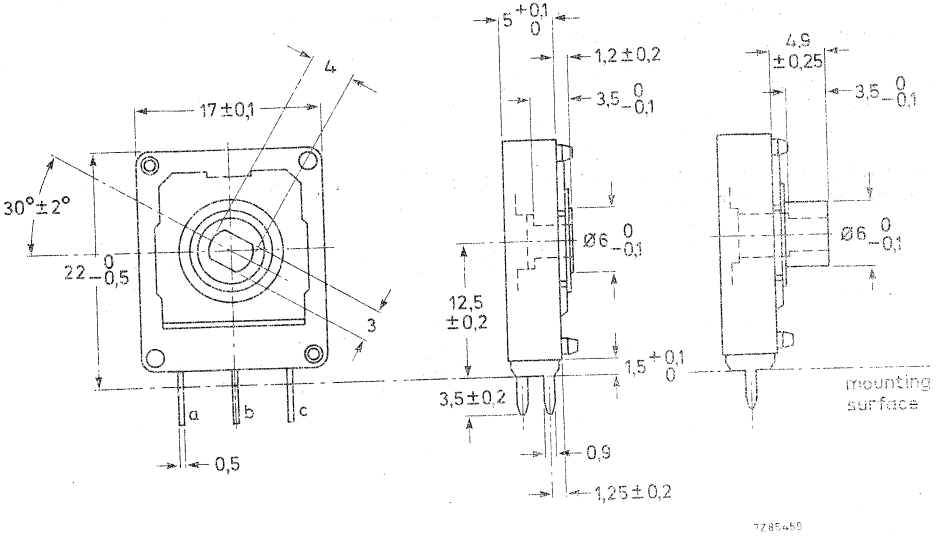


Fig. 3 Hole pattern, viewed from component side. a: no tap; b: one tap; c: 2 taps.

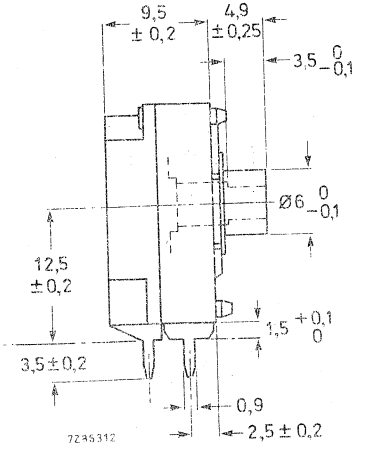
Vertical version, rotor drawn at fully counter-clockwise position (starting position)



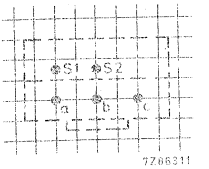
Without switch:

staggered terminals, flat rotor

terminals in line, protruding rotor



Terminals in line, protruding rotor, with switch.



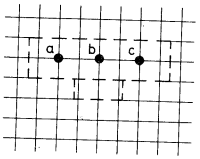
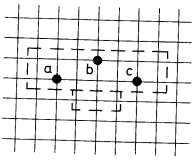
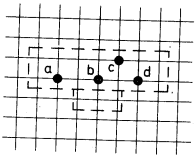
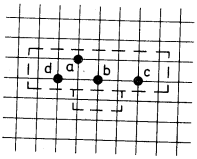
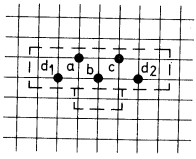
Hole pattern for type with terminals in line, with switch, viewed from the component side.

Fig. 4.

Vertical versions, available types, with flat or protruding rotor.

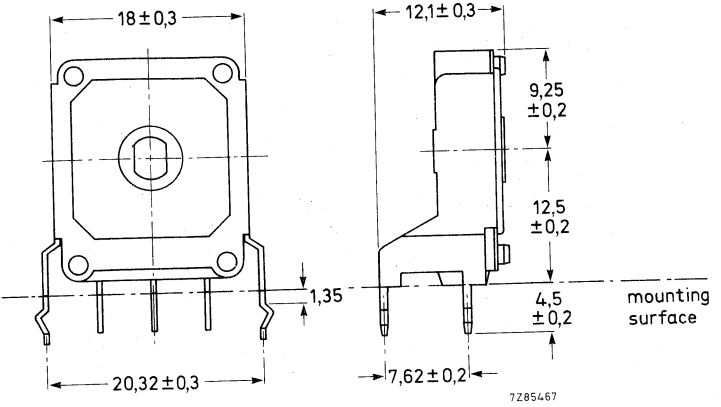
terminals	in line		staggered	
switch	no	yes	no	yes
no taps	●	●	●	–
lin/log, one tap	–	–	●	●
rev. log, one tap	–	–	●	●
two taps	–	–	●	●

Hole patterns for connection to printed-wiring boards with a grid pitch of 2,54 mm, viewed from component side, vertical types

	terminals in line	staggered terminals
no taps		
lin or log, with one tap	–	
reverse log with one tap	–	
with two taps	–	

7Z85465.1

Fig. 5.



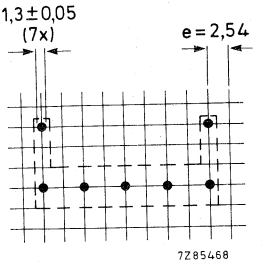


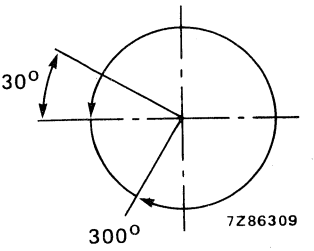
Fig. 6 Bracket.

DEVELOPMENT SAMPLE DATA

MECHANICAL DATA OF THE SWITCH

Operating torque, initial	50 to 100 mNm
Operating angle, max.	30 degrees
Radial spindle-play in off position	⩽ 10 degrees

See also Fig. 4.



ELECTRICAL DATA OF THE SWITCH

D.C. voltage/current rating	14,4 V/3,5 A
Dielectric strength	
initial	500 V d.c. during 1 minute
after 21 days humidity test IEC 68	100 V d.c. during 1 minute
Contact resistance	
initial	⩽ 20 mΩ
after 10 000 cycles (under load)	⩽ 50 mΩ
Insulation resistance, between switch contacts, and between interconnected contacts and housing	
initial	⩾ 100 MΩ
after 21 days humidity test IEC 68-C	⩾ 2 MΩ

TECHNICAL DATA

Unless otherwise specified, all values are valid at an ambient temperature of 18 to 22 °C, an atmospheric pressure of 860 to 1060 mbar and a relative humidity of 45 to 75%.

For measuring methods, see IEC publications 393-1 and 68. The terms used are explained in the Glossary of terms.

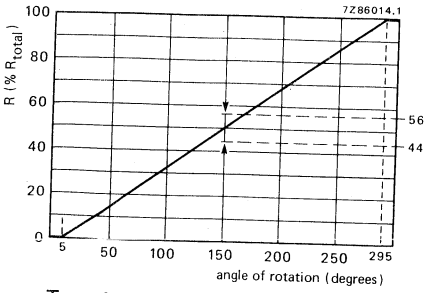
nominal resistance	resistance law according to Fig. 7 type	limiting element voltage V(d.c.)		limiting slider current mA	
		at 40 °C	at 70 °C	at 40 °C	at 70 °C
22 Ω	A	2	1,4	95	67
47 Ω		3	2	65	46
100 Ω		4,4	3	44	31
220 Ω		6,6	4,7	30	21
470 Ω		9	6	20	14
1 kΩ		14	10	14	10
2,2 kΩ		21	14	9,5	6,7
4,7 kΩ		30	21	6,5	4,6
10 kΩ		44	31	4,5	3,2
22 kΩ		66	47	3	2,1
47 kΩ		97	68	2,0	1,5
100 kΩ		141	100	1,4	1
220 kΩ		210	148	1	0,7
470 kΩ		306	216	0,7	0,5
1 MΩ		447	316	0,4	0,3
2,2 MΩ		500	469	0,3	0,2
4,7 MΩ		500	500	0,2	0,1
1 kΩ	C R, H, S, J, T, K or U	10	7	10	7
2,2 kΩ		14	10	6,7	4,8
4,7 kΩ		21	15	4,6	3,3
10 kΩ		31	22	3,2	2,2
22 kΩ		47	33	2,1	1,5
47 kΩ		68	48	1,5	1
100 kΩ		100	70	1	0,7
220 kΩ		148	104	0,7	0,5
470 kΩ		216	153	0,5	0,3
1 MΩ		316	223	0,3	0,2
2,2 MΩ		469	331	0,2	0,15

DEVELOPMENT SAMPLE DATA

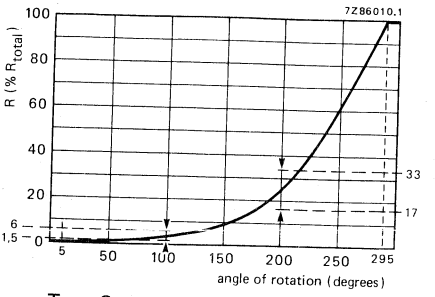
Resistance range (E3 series) linear law logarithmic law	22 Ω to 4,7 MΩ 1 kΩ to 2,2 MΩ
Tolerance on the nominal resistance	± 20%*
Resistance law and tolerances	see Fig. 6a to 6j
Maximum dissipation at T_{amb} = 40 °C (P_{max}) linear law logarithmic law	0,2 W 0,1 W } derating see Fig. 7
Test voltage for 1 minute	500 V, 50 Hz
Working temperature range	–25 to + 70 °C
Storage temperature range	–55 to + 100 °C
Minimum effective resistance	⩽ 2% of R_n
Minimum resistance at the tap	⩽ 1,5% of R_n
Contact resistance moving, initially linear law logarithmic law	⩽ 2,5% of R_{ac} ⩽ 5% of R_{ac}
Contact resistance variation, initially (acc. to IEC 393-1, amendment 1a (1977) linear law logarithmic law	⩽ 4% of R_{ac} ⩽ 8% of R_{ac}
Temperature coefficient of resistance	± 500 . 10^{-6}/K
Insulation resistance after damp heat test (IEC 68, test C, 21 days)	> 100 MΩ
Climatic category (IEC 68)	25/070/10
Operating torque	5 to 20 mNm
Ratio max./min. operating torque	⩽ 3
Permissible end stop torque	⩽ 800 mNm
Angle of rotation, without switch	300 ± 2°
Effective angle of rotation, without switch	290 ± 2,5°

* For potentiometers with a tap the tolerance on R_{ad} as well as on R_{dc} = ± 20%.

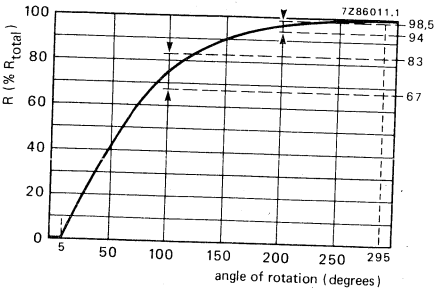
Characteristics of potentiometers without switch



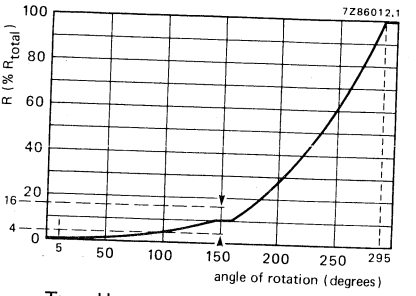
Type A
Fig. 7a Linear law.



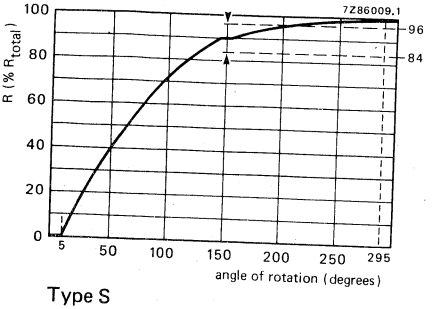
Type C
Fig. 7b Logarithmic law.



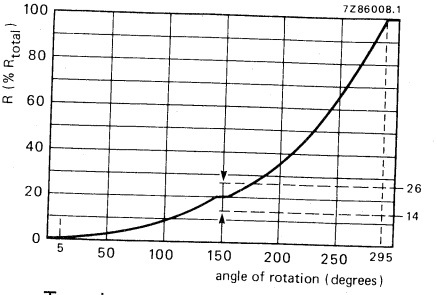
Type R
Fig. 7c Reversed logarithmic law.



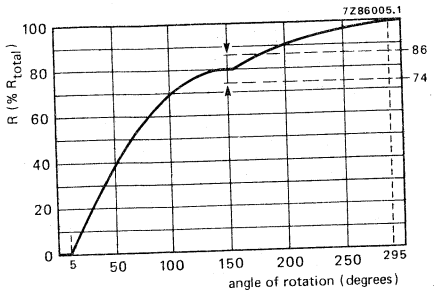
Type H
Fig. 7d Logarithmic law, tap at 10%.



Type S
Fig. 7e Reversed logarithmic law, tap at 90%.

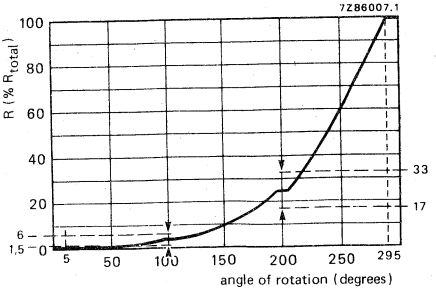


Type J
Fig. 7f Logarithmic law, tap at 20%.



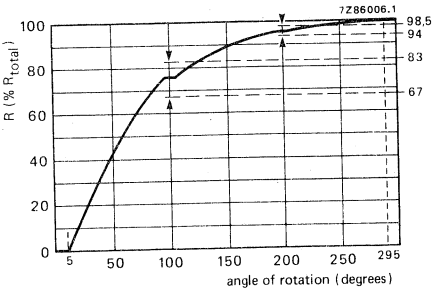
Type T

Fig. 7g Reversed logarithmic law, tap at 80%.



Type K

Fig. 7h Logarithmic law, taps at 1/3 and 2/3.



Type U

Fig. 7j Reversed logarithmic law, taps at 1/3 and 2/3.

Derating graph

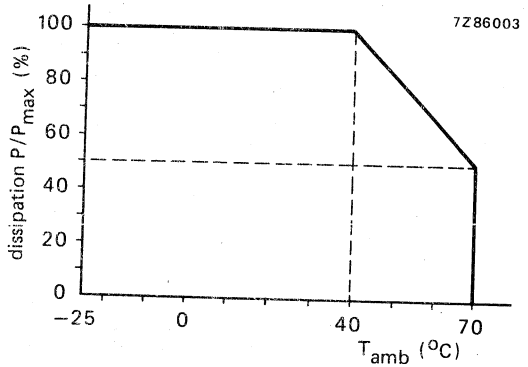


Fig. 8 Maximum permissible dissipation as a function of ambient temperature.

MARKING

The potentiometers are marked with:

- nominal resistance (in RKM code acc. to IEC 62)
- resistance law
- code for period and year of manufacture.

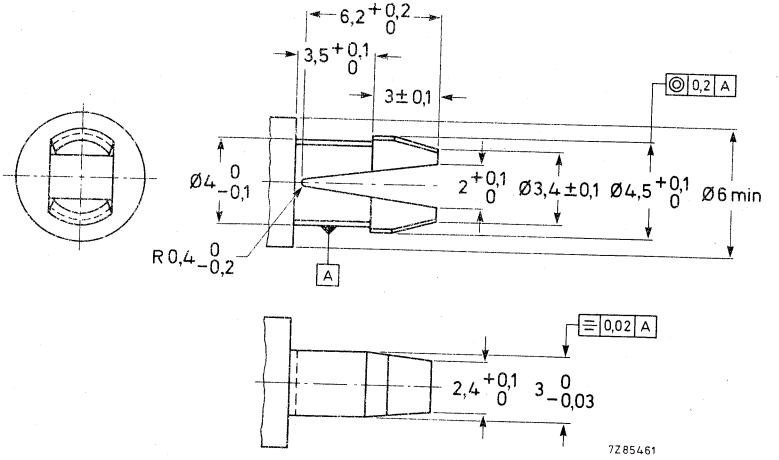


Fig. 9 Example of ϕ6 mm spindle end.
Material: injection moulded polycarbonate.

COMPOSITION OF THE PART NUMBER

22PP500 . . . . . .

code for switch
0 = without switch 1 = with s.p.s.t. switch

code for terminal configuration
A = in line
B = staggered*

code for resistance law
A = linear
C = logarithmic
R = reversed logarithmic
H = logarithmic tap at 10%
S = reversed log., tap at 90%
J = logarithmic, tap at 20%
T = reversed log., tap at 80%
K = logarithmic tap at 1/3 and 2/3
U = reversed log., tap at 1/3 and 2/3

code for resistance value	
05 =	22 Ω
09 =	47 Ω
14 =	100 Ω
18 =	220 Ω
23 =	470 Ω
27 =	1 kΩ
32 =	2,2 kΩ
36 =	4,7 kΩ
41 =	10 kΩ
45 =	22 kΩ
49 =	47 kΩ
54 =	100 kΩ
58 =	220 kΩ
63 =	470 kΩ
67 =	1 MΩ
72 =	2,2 MΩ
76 =	4,7 MΩ

code for detents
0 = 0 detents
1 = 1 detent

code for mounting style, rotor and bracket

	vertical		horizontal
	without bracket	with bracket	without bracket
flat rotor	VF	VB	HF
pro-truding rotor	VP	VC	HP

DEVELOPMENT SAMPLE DATA

ORDERING INFORMATION

Once a part number has been fixed, a catalogue number will be issued by the supplier (see next page). On delivery, boxes will be marked with both part number and catalogue number.

Note: Potentiometers with switch are delivered as such, not in separate modules. Loose switches are not available.

* Vertical types only.

Conversion list catalogue number/part number

catalogue number	part number
2322 500 00103	22PP5000VPB0A23
00104	A27
00105	A32
00106	A36
00107	A41
00108	A45
00109	A49
00111	A54
00112	A58
00113	A63
00114	A67

catalogue number	part number
2322 500 00503	22PP5000HPA0A23
00504	A27
00505	A32
00506	A36
00507	A41
00508	A45
00509	A49
00511	A54
00512	A58
00513	A63
00514	A67

MODULE CARBON CONTROL POTENTIOMETERS

vertical version, tandem type

This data sheet should be read in conjunction with that of the PP17M-series.
Potentiometers PP17MT conform to the specifications of the PP17M vertical version with protruding rotor, but are tandem types. For this reason only changes or additions, relevant to PP17MT are given in here.

QUICK REFERENCE DATA

Resistance range	
linear resistance law	22 Ω to 4,7 MΩ
logarithmic resistance law	1 kΩ to 2,2 MΩ
balance law	

MECHANICAL DATA

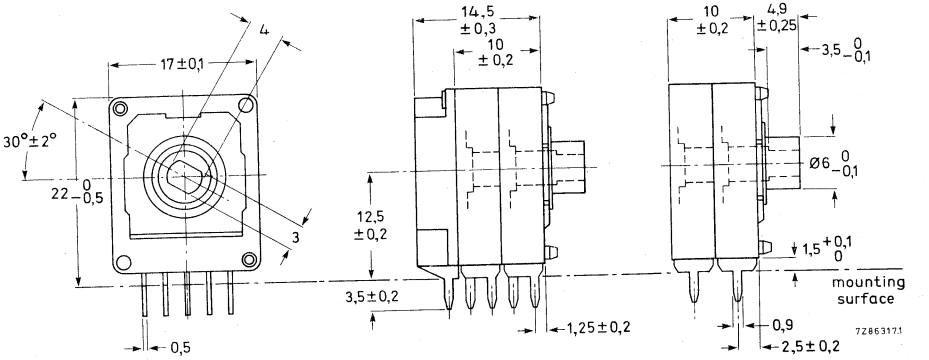
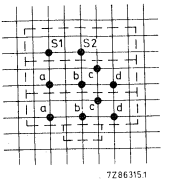


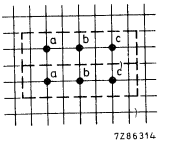
Fig. 1 Examples of combinations and hole patterns, viewed from component side.

a: staggered, lin/log, one tap with switch

b: in line, no taps no switch



a



b

Possible combinations

terminals	in line		staggered	
switch	no	yes	no	yes
no taps	●	●	●	—
lin/log, one tap	—	—	●	●
rev. log, one tap	—	—	●	●
two taps	—	—	●	●

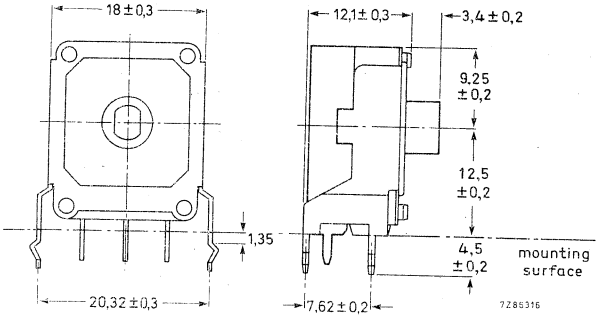


Fig. 3 With bracket, no switch, terminals in line.

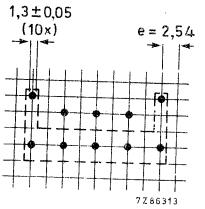
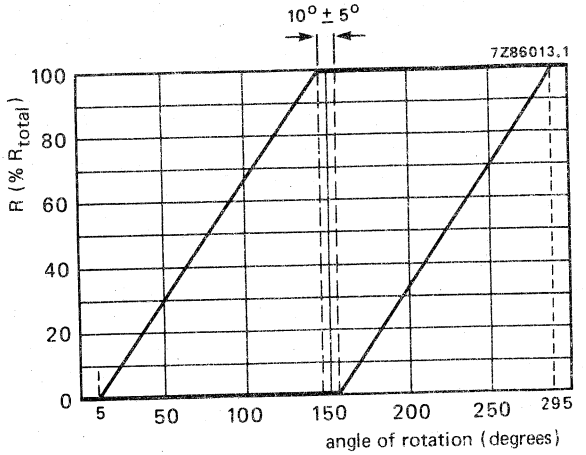


Fig. 3a Corresponding hole pattern.

Resistance law and tolerances, balance ("X")



Ganging tolerance (tandem module potentiometer)			
linear law, at values between 10 and 90% of R_{tot}	<	2	dB
(reversed) logarithmic law			
at attenuations between 0 and 20 dB	<	2	dB
at attenuations between 20 and 40 dB	<	3	dB
at attenuations between 30 and 60 dB	<	4	dB
with tap at 10% of R_{tot}, tap load 1% of R_{tot}			
at attenuations between 0 and 20 dB	<	2	dB
at attenuations between 20 and 40 dB	<	3	dB
at attenuations between 30 and 60 dB	<	4	dB
at attenuations between 60 and 70 dB	<	6	dB
at attenuations between 70 and 80 dB	<	7	dB

DEVELOPMENT SAMPLE DATA

COMPOSITION OF THE PART NUMBER, see "possible combinations"

22PP500 . . . . . .

code for switch

0 = without switch
1 = with s.p.s.t. switch

code for terminal configuration

A = in iine
B = staggered

code for resistance law

A = linear
C = logarithmic
R = reversed logarithmic
H = logarithmic tap at 10%
S = reversed log., tap at 90%
J = logarithmic, tap at 20%
T = reversed log., tap at 80%
K = logarithmic tap at 1/3 and 2/3
U = reversed log., tap at 1/3 and 2/3
X = balance

code for resistance value

05	= 22	Ω
09	= 47	Ω
14	= 100	Ω
18	= 220	Ω
23	= 470	Ω
27	= 1	kΩ
32	= 2,2	kΩ
36	= 4,7	kΩ
41	= 10	kΩ
45	= 22	kΩ
49	= 47	kΩ
54	= 100	kΩ
58	= 220	kΩ
63	= 470	kΩ
67	= 1	MΩ
72	= 2,2	MΩ
76	= 4,7	MΩ

single

code for mounting style, rotor and bracket

	vertical without bracket	vertical with bracket	horizontal without bracket
flat rotor	VF	VB	HF
pro-truding rotor	VP	VC	HP

code for detents

0 = 0 detents
1 = 1 detent

tandem

code for mounting style, rotor and bracket

	vertical without bracket	vertical with bracket
pro-truding rotor	VT	VD

ORDERING INFORMATION

Once a part number has been fixed, a catalogue number will be issued by the supplier. On delivery, boxes will be marked with both part number and catalogue number.

Note: tandem potentiometers, balance potentiometers and tandem potentiometers with switch are delivered as such, not in loose modules.

CERMET POTENTIOMETERS & FOCUS POTENTIOMETER UNITS C

ENCLOSED 10mm CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E6-series), linear law	47 Ω to 10 MΩ
Maximum dissipation at 40 °C	0,5 W
Climatic category, IEC 68–2	55/125/56

APPLICATION

These potentiometers were for preset resistance control with provision for re-adjustment. The completely enclosed construction renders these potentiometers for application in poor conditioned environments.

DESCRIPTION

These preset potentiometers comprise a metal-glaze resistive element on a ceramic base. The actuating device is a plastic rotor. Adjustment is by means of hexagonal or cross-shaped recesses. The overall width of 9,6 mm allows for high density use with air-gap isolation on a 2,54 mm grid; either horizontal or vertical mounting. The glass-filled synthetic resin housing is fire resistant. The potentiometers, which are manufactured fully automatically, offer stable high quality performance and can be mounted by automatic insertion machines.

MECHANICAL DATA

Dimensions in mm

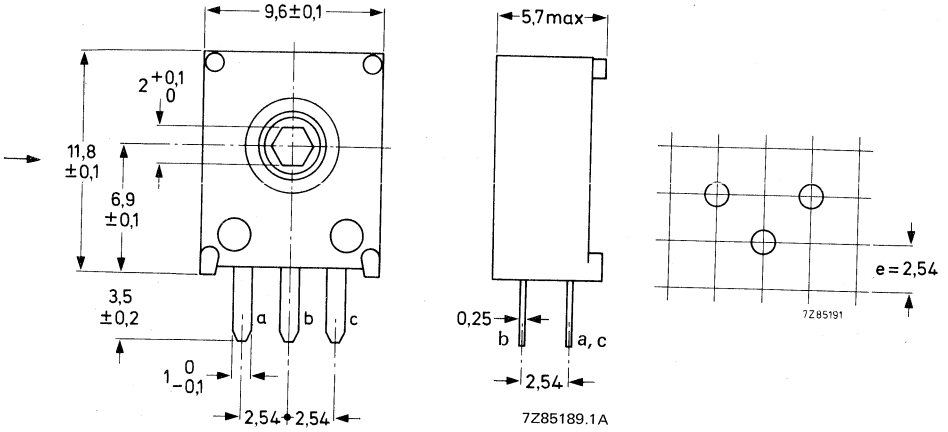


Fig. 1 Vertical mounting version.

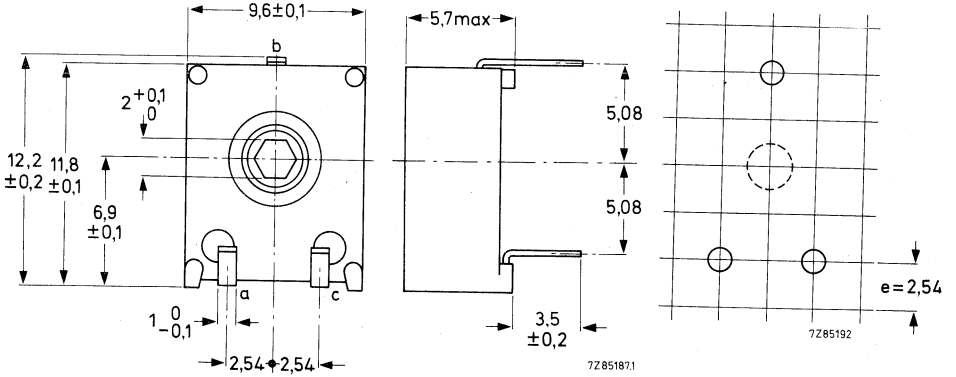
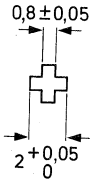


Fig. 2 Horizontal mounting version.



Dimensions of the cross-shaped recess.

TECHNICAL DATA

Mass		~ 1,5 g
Resistance range (E6-series)		47 Ω to 10 MΩ
Standard tolerance		± 10%
Resistance law		linear, see Fig. 6
Rated dissipation at 40 °C (P_{max})		0,5 W, see Fig. 5
Limiting element voltage		250 V (d.c.)
Limiting slider current		$\sqrt{\frac{P_{max}}{R_N}}$
Minimum effective resistance		⩽ 0,5% of R_N or 2 Ω, whichever is greater
Rotational noise limits (contact resistance variation)		⩽ 1,0% of R_N
Temperature coefficient in the range −55 °C to + 125 °C		
$R_N \leqslant 100\ \Omega$		± 200 . 10^{-6}/K
$100 < R_N < 1\ M\Omega$		± 50 . 10^{-6}/K
$R_N \geqslant 1\ M\Omega$		± 100 . 10^{-6}/K
Operating torque		0,5 to 10 mNm
Permissible end-stop torque		max. 50 mNm
Total mechanical angle of rotation		300 ± 5°
Effective angle of rotation		295 ± 5°
Settability		0,1% within 10 s
Climatic category according to IEC 68–2		55/125/56
Climatic sequence	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
Damp heat, steady state	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
Mechanical endurance (200 cycles)	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
Electrical endurance (1000 h at 70 °C, cyclic)	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
Change of temperature (between −55 °C and + 125 °C)	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 2%
	$\frac{\Delta V_{ab}}{V_{ac}}$	⩽ 1%
Resistance to soldering heat	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 0,5%
Bump	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 1%
Vibration	$\frac{\Delta R_{ac}}{R_{ac}}$	⩽ 1%
	$\frac{\Delta V_{ab}}{V_{ac}}$	⩽ 0,5%

DEVELOPMENT SAMPLE DATA

DERATING

Potentiometers covered by this specification are derated from 100% rated dissipation at 40 °C to zero dissipation at 125 °C. The dissipation below 40 °C is the rated dissipation.

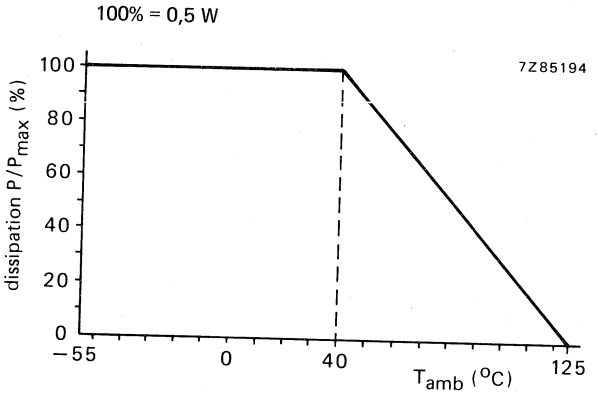


Fig. 5 Dissipation as a function of ambient temperature.

RESISTANCE LAW

Potentiometers covered by this specification are normally linear.

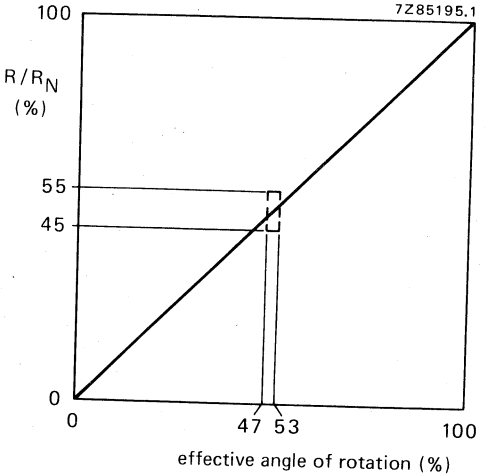


Fig. 6 Linear resistance law.

MARKING

The potentiometers are marked with the rated resistance value, according to IEC 62, e.g. 220 Ω = 220 R; 10 kΩ = 10 k; 1 MΩ = 1 MO.

The package is marked with:
- catalogue number,
- date of production,
- quantity.

COMPOSITION OF THE CATALOGUE NUMBER

2322 484 A B C D E

A:
0 = vertical, cross-shaped recess
1 = vertical, hexagonal recess
5 = horizontal, cross-shaped recess
6 = horizontal, hexagonal recess

B: code for tolerance:
1 = ± 10%

C D: resistance value code: first two significant figures of the resistance value followed by:
9 for R of 47 Ω and 68 Ω
1 for R of 100 to 680 Ω
2 for R of 1 kΩ to 6,8 kΩ
3 for R of 10 kΩ to 68 kΩ
4 for R of 100 kΩ to 680 kΩ
5 for R of 1 MΩ to 6,8 MΩ
6 for R of 10 MΩ

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393–1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounting by their terminations on a printed wiring board.

When drying is called for, procedure I of IEC 393–1, sub. 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the slider is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 230 ± 10 °C, 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C, 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.25	Eb	Bump	acceleration: 390 m/s² number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 98 m/s², 6 h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}3\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; −25 °C; + 20 °C; + 70 °C; + 20 °C	$-50 < TC < +50 \cdot 10^{-6}/K$
6.23	Na	Change of temperature	−55 °C and + 125 °C; 5 cycles	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}1\%$
6.26	–	Climatic sequence		$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$
6.26.2	Ba	Dry heat	16 h at 125 °C	
6.26.3	D	Damp heat accel. 1st cycle	24 h at 55 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at −55 °C	
6.26.6	D	Damp heat, remaining cycle	24 h at 55 °C 95 - 100% R.H.	
(6.30)	–	Electrical endurance	T_{amb}: 40 °C, 1000 h, cyclic (1,5 h on and 0,5 h off, b at 0,67 ac) Load: 0,5 W between a and c	CRV < 1% of R_N $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}5\%$
			Load: 0,33 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 5\%$

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.29	–	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ CRV $< 1\%$ of R_N
(6.27)	C	Damp heat steady state	wiper at 0,67 a - c no load; recovery 24 h at 22 ± 1 °C, 50% R.H. ± 5%	CRV $< 1\%$ of R_N $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 2\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$

10 mm CERMET PRESET POTENTIOMETERS

QUICK REFERENCE DATA

Resistance range (E6-series), linear law	100 Ω to 6,8 MΩ
Maximum dissipation at 70 °C	0,5 W
Climatic category, IEC 68	55/125/56

APPLICATION

These potentiometers are for preset resistance control with provision for re-adjustments. They are particularly suitable for use in professional apparatus and/or in those applications where stability is of extreme importance.

DESCRIPTION

These potentiometers comprise a resistance element of thick film, with particles of conductive metal dispersed in it. The element is supported by a non-conductive temperature-resistant ceramic base. The terminals a and c (see Figs 1 to 3) are connected to the ends of the resistance element; terminal b is connected to the slider.

The potentiometers are available in three versions: two for horizontal and one for vertical mounting on printed-wiring boards.

Outlines

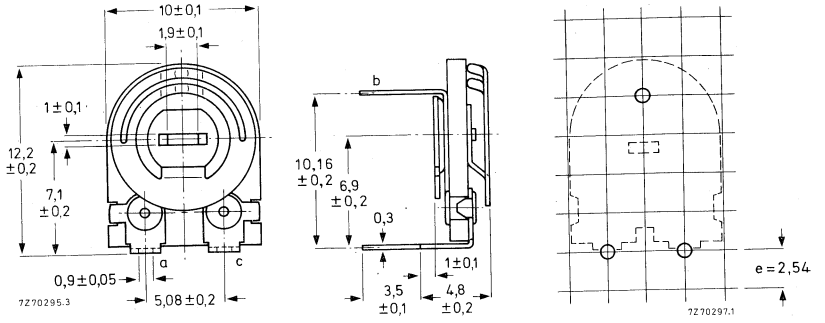


Fig. 1 Potentiometer for horizontal mounting, 2322 482 2 . . . . .

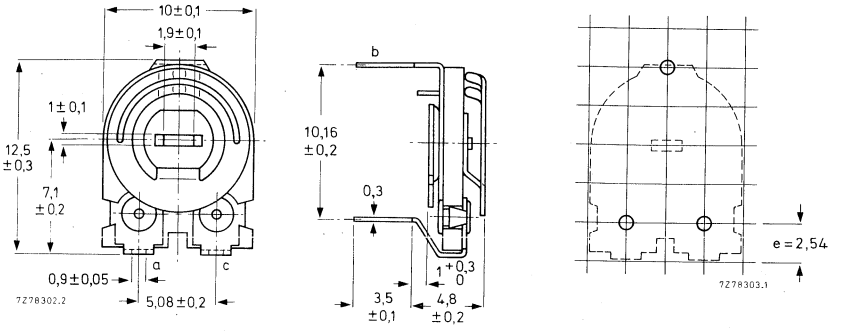


Fig. 2 Potentiometer for horizontal mounting, 2322 482 4 . . . .

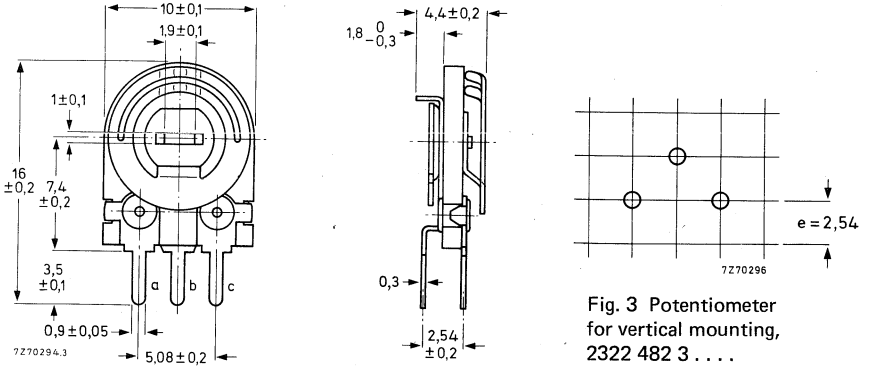


Fig. 3 Potentiometer for vertical mounting, 2322 482 3 . . . .

TECHNICAL DATA

Unless stated otherwise, all electrical values have been determined at an ambient temperature of 15 to 35 °C, an air pressure of 860 to 1060 mbar and a relative humidity of 45 to 75%. For terms and test methods see IEC publication 393-1.

Nominal resistance (R_n)	100 Ω to 6,8 MΩ, see Table 1
Tolerance on the nominal resistance	± 20% and ± 10%
Resistance law and tolerances	linear, see Fig. 4
Terminal resistance	⩽ 0,5% of R_{total} or 2 Ω, whichever is the greater
Contact resistance variation (CRV)	⩽ 0,5% of R_{total}
Maximum dissipation (P_{max}) at 70 °C	0,5 W, see Fig. 5

Limiting voltage (d.c.)	250 V
Limiting slider current	$\sqrt{\left(\frac{P_{max}}{R_{total}}\right)}$
Operating temperature range	−55 to +125 °C
Temperature coefficient	
$R_n \leqslant 1$ MΩ	± 50.10^{-6}/K
$R_n > 1$ MΩ	± 100.10^{-6}/K
Operating torque	4 to 30 mNm
Permissible end stop torque	⩽ 50 mNm
Effective angle of rotation	220 ± 5°
Mechanical angle of rotation	235 ± 5°
Rotational life	200 cycles
Settability	1°/oo of R_{total} within 10 s
Mass	approx. 1,5 g

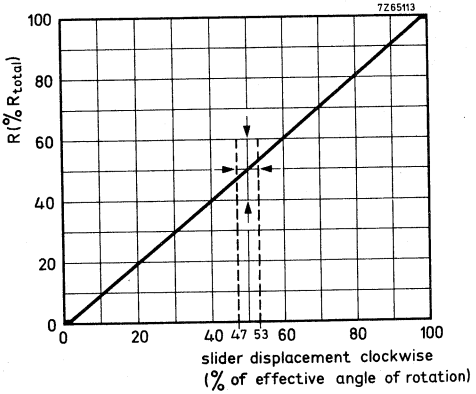


Fig. 4 Linear law.

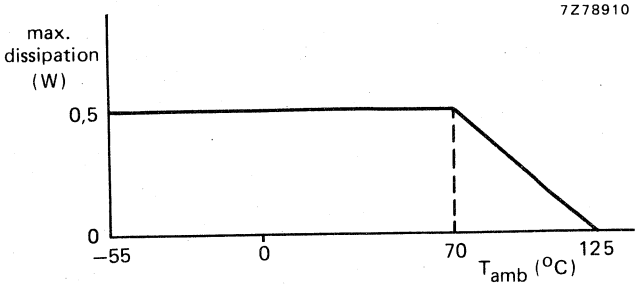


Fig. 5 Maximum dissipation as a function of ambient temperature.

COMPOSITION OF THE CATALOGUE NUMBER

2322 482 .....

code for version

2 = potentiometer for horizontal mounting, according to Fig. 1
3 = potentiometer for vertical mounting, according to Fig. 3
4 = potentiometer for horizontal mounting, according to Fig. 2

code for nominal resistance, see Table 1

code for tolerance
0 = ± 20%
2 = ± 10%

Table 1

nominal resistance	code in cat. number	nominal resistance	code in cat. number
100 Ω	101	33 kΩ	333
150 Ω	151	47 kΩ	473
220 Ω	221	68 kΩ	683
330 Ω	331	100 kΩ	104
470 Ω	471	150 kΩ	154
680 Ω	681	220 kΩ	224
1 kΩ	102	330 kΩ	334
1,5 kΩ	152	470 kΩ	474
2,2 kΩ	222	680 kΩ	684
3,3 kΩ	332	1 MΩ	105
4,7 kΩ	472	1,5 MΩ	155
6,8 kΩ	682	2,2 MΩ	225
10 kΩ	103	3,3 MΩ	335
15 kΩ	153	4,7 MΩ	475
22 kΩ	223	6,8 MΩ	685

TESTS AND REQUIREMENTS

Clause numbers of tests and conditions of test refer to IEC 393–1 (potentiometers, part 1: terms and methods of test).

The potentiometers have been tested whilst mounting by their terminations on a printed-wiring board.

When drying is called for, procedure I of IEC 393–1, sub. 5.2. is used (24 ± 4 h, 55 ± 2 °C, R.H. 20%).

When the contact resistance variation (CRV) is measured, the slider is rotated in both directions over 90% of the effective resistance for a total of 6 cycles. The maximum deviations in the last 3 cycles are taken into account. Wiper speed: 2 cycles/minute; bandwidth 10 Hz to 5 kHz.

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.22.3	T	Solderability	solder bath: 230 ± 10 °C, 2 ± 0,5 s	good tinning
6.22.4	Tb	Resistance to heat	solder bath: 350 ± 10 °C 3,5 ± 0,5 s	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.25	Eb	Bump	acceleration: 40g number of bumps: 4000	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$
6.24	Fc	Vibration	frequency: 10 - 500 Hz amplitude: 0,75 mm or 10g, 3 directions, 2h per direction	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
6.13		Temperature characteristic of resistance	temp. cycle: + 20 °C; –25 °C; + 20 °C; + 70 °C + 20 °C	$-50 < TC < +50.10^{-6}/K$
6.23	Na	Change of temperature	–55 °C and + 125 °C; 5 cycles, ½ h	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}1\%$
6.26	–	Climatic sequence		
6.26.2	Ba	Dry heat	16 h at 70 °C	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ operating torque ⩽ 36 mNm
6.26.3	Db	Damp heat accel. 1st cycle	24 h at 55 ± 2 °C 95 - 100% R.H.	
6.26.4	Aa	Cold	2 h at –55 ± 3 °C	
6.26.6	D	Damp heat, remaining cycle	24 h at 55 ± 2 °C 95 - 100% R.H.	
6.30	–	Electrical endurance	T_{amb}: 70 °C, 1000 h cyclic (1,5 h on and 0,5 h off, b at 0,67 ac)	CRV < 1% of R_N
			Load: 0,5 W between a and c	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
			Load: 0,33 W between a and b	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 3\%$

IEC 393–1 clause	IEC 68–2 test method	test	procedure	typical result
6.29	—	Mechanical endurance	200 cycles, 4 cycles/min no load	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 2\%$ CRV $< 0{,}5\%$ of R_N
6.27	Ca	Damp heat steady state	b at 0,67 a - c no load; 56 days	CRV $< 0{,}5\%$ of R_N $\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta R_{ab}}{R_{ab}} \leqslant 1\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
			load a - c 0,05 W	$\frac{\Delta R_{ac}}{R_{ac}} \leqslant 0{,}5\%$ $\frac{\Delta V_{ab}}{V_{ac}} \leqslant 0{,}2\%$
			load a - c 0,03 W	$\frac{\Delta R_{ab}}{R_{ab}} \leqslant 2\%$
Immersion in cleaning solvents		Immersion in boiling mixture of 1.1.2. trichlorotrifluoraethane and isopropanol (75%/25%) for 5 ± 0,5 min., followed by 5 min drying (rubbing or wrapping excluded).		Marking legible, no damage. $\Delta R_{ac}/R_{ac} \leqslant 0{,}5\%$; CRV $\leqslant 0{,}5\%$; operating torque: 2 to 10 mNm.

FOCUS POTENTIOMETER UNITS

- For low-bi colour picture tubes*, focusing voltage approx. 4,5 kV
- In conjunction with triplers or 4 diode-split line output transformers

QUICK REFERENCE DATA

	2322 460 90016	2322 460 90018	2322 460 90022
Nominal resistance	24 MΩ ± 20%	59 MΩ ± 20%	24 MΩ ± 10%
Maximum dissipation at 70 °C	3,8 W	3,8 W	3,8 W
Climatic category, IEC 68	20/070/21	20/070/21	20/070/21

APPLICATION

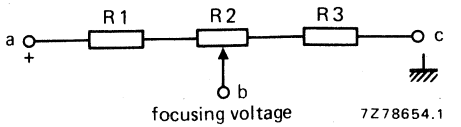
These focus potentiometer units are for adjustment of the focusing voltage for low-bi colour picture tubes.

DESCRIPTION

The potentiometer units comprise three resistance elements, which are connected in series. The centre element is provided with a slider (see also Fig. 1). The resistance elements are of the thick-film type; they are attached to a non-conductive temperature-resistant base (Al_2O_3, 96%). The housing of the potentiometer units is of grey, self-extinguishing, glass-fibre-filled thermoplastic material.
The units 2322 460 90016 and 2322 460 90022 are provided with snap-in clasps for mounting; unit 2322 460 90018 is suited for direct mounting e.g. to a tripler unit.

Fig. 1.

a = focus output voltage of tripler unit;
b = focusing voltage;
c = earth.



* Focus potentiometer units for hi-bi colour picture tubes are supplied under catalogue numbers 2322 460 90027, 2322 460 90028 and 2322 460 90029; see the relevant data sheet.

OUTLINES

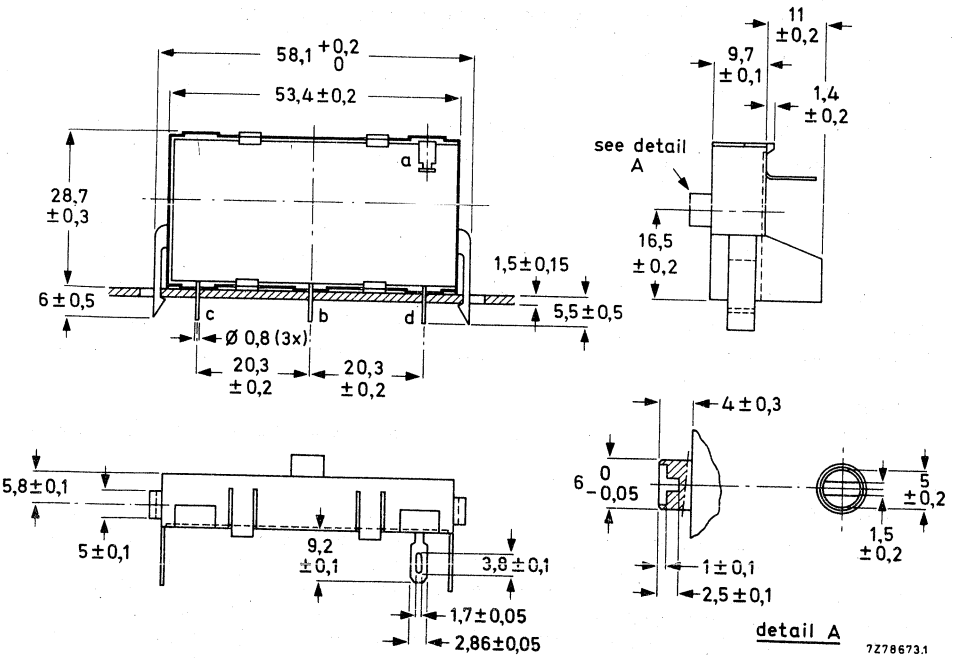


Fig. 2 Potentiometer unit **2322 460 90016**. The indication of the terminals corresponds to those shown in Fig. 1; terminal d serves for mechanical fitting of the unit. Solder tag a fits Faston receptacles (2,8 x 0,5).

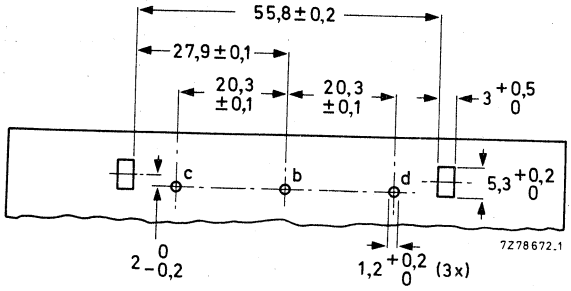


Fig. 3 Piercing diagram for board mounting of potentiometer unit **2322 460 90016** (component side).

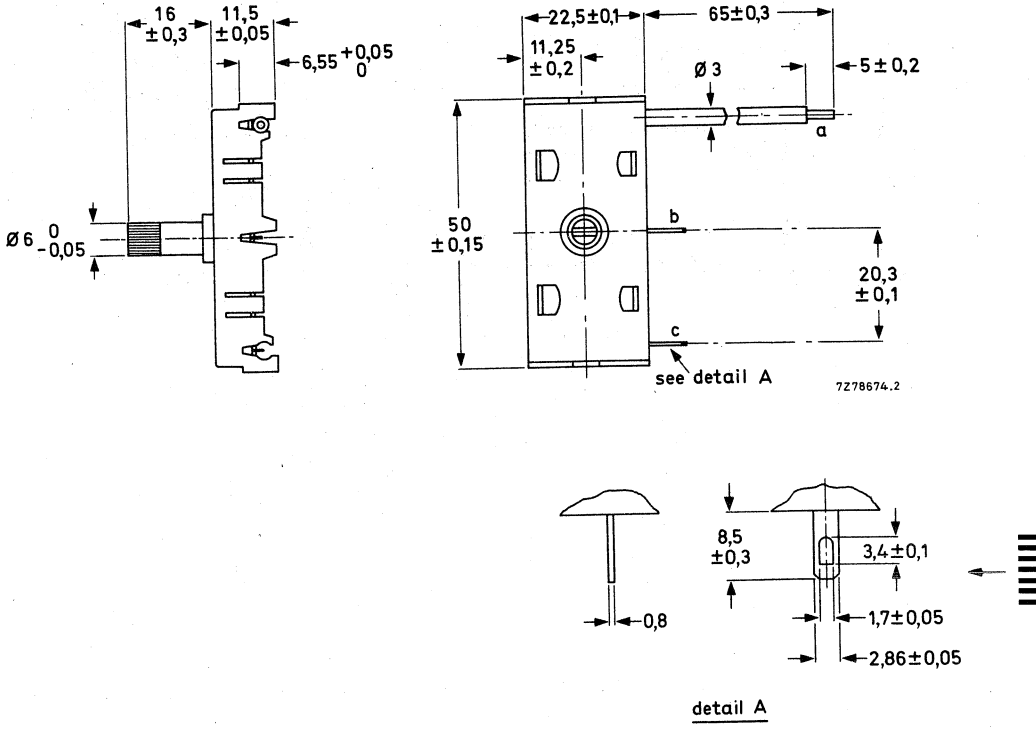


Fig. 4 Potentiometer unit **2322 460 90018.** The indication of the terminals corresponds to those shown in Fig. 1.

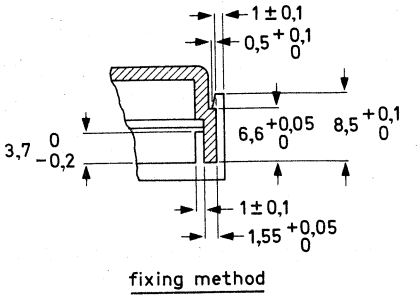


Fig. 5 Method of fixing potentiometer unit **2322 460 90018** e.g. to a tripler unit BG 1897-541.

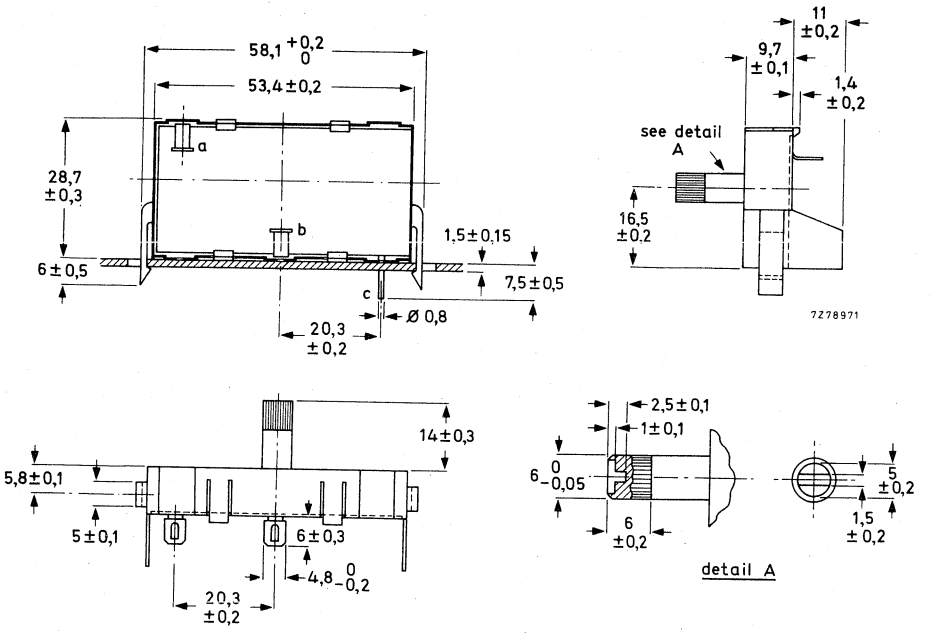


Fig. 6 Potentiometer unit **2322 460 90022.** The indication of the terminals corresponds to those shown in Fig. 1. The solder tags fit on Faston receptacles (4,8 x 0,5).

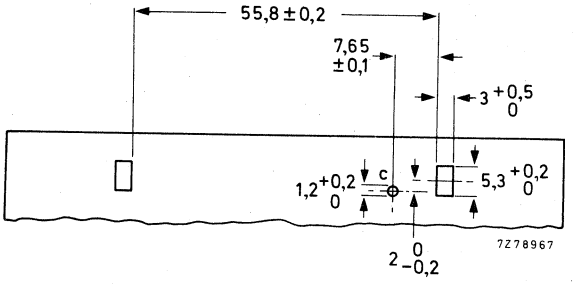


Fig. 7 Piercing diagram for board mounting of potentiometer unit **2322 460 90022** (component side).

TECHNICAL DATA

	2322 460		
	90016	90018	90022
Nominal resistance value (R1 + R2 + R3, Fig. 1)	24 MΩ	59 MΩ	24 MΩ
Tolerance on nominal resistance	± 20%	± 20%	± 10% *
Resistance ratio at 25 °C (focusing voltage range)			
$\frac{R3 + R2}{R_{tot}}$	⩾ 0,73	⩾ 0,65	⩾ 0,73
$\frac{R3}{R_{tot}}$	⩽ 0,50	⩽ 0,42	⩽ 0,50
Variation in resistance ratios at 70 °C	⩽ 3%	⩽ 3%	⩽ 3%
Resistance law of R2	linear	linear	linear
Contact resistance	⩽ 250 kΩ	⩽ 600 kΩ	⩽ 250 kΩ
Maximum dissipation at 70 °C	3,8 W	3,8 W	3,8 W
Limiting element voltage	8,5 kV	8,5 kV	8,5 kV
Insulation resistance between interconnected terminals and mounting base at 500 V (d.c.)	$> 10^3$ MΩ	$> 10^3$ MΩ	$> 10^3$ MΩ
Test voltage between interconnected terminals and mounting base for 1 min	10 kV	10 kV	10 kV
Operation temperature range	−20 to + 70 °C	−20 to + 70 °C	−20 to + 70 °C
Climatic category, IEC 68	20/070/21	20/070/21	20/070/21
Operating torque	3,5 to 50 mNm	3,5 to 50 mNm	3,5 to 30 mNm ←
Permissible end stop torque	⩽ 80 mNm	⩽ 80 mNm	⩽ 80 mNm ←
Permissible axial spindle load	⩽ 12 N	⩽ 12 N	⩽ 12 N

Note

Potentiometer units with different resistance values and resistance ratios, connecting terminals and spindles are available on request.

MARKING

The potentiometer units are marked with last five digits of the catalogue number, and period and year of manufacture.

* The ± 10% tolerance allows the possibility of applying a V_{g2} adjustment, with a total resistance of e.g. 2,7 MΩ, between terminal c and earth; as a result the resistance ratios become ⩾ 0,75 and ⩽ 0,55 respectively.

TESTS AND REQUIREMENTS

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Na	Rapid change of temperature	5 cycles of ½ h at −20 °C and ½ h at + 70 °C.	No damage; R_{tot} and resistance ratios shall be within tolerance limits.
	Vibration	50 Hz, 1 mm, 3 directions, 2 h per direction.	
	Dry heat	16 h at + 70 °C, no voltage applied. Reconditioning 2 h.	
	Cold	16 h at −20 °C; no voltage applied; 2 h reconditioning.	
	Rotational life	50 cycles at a rate of 10 cycles/min, no voltage applied.	
	Endurance	1000 h at 70 °C, 9 kV (d.c.) applied; slider adjusted to 5 kV with respect to earth.	Stability of preset voltage ⩽ 0,5%.
	Humidity	21 days at 40 °C, R.H. 93%; 650 V (d.c.) applied.	contact resistance and insulation resistance shall meet initial requirements.
	Resistance ratios	4 h at 70 °C, 9 kV (d.c.) applied; slider adjusted to 5 kV with respect to earth at 25 °C.	variation of resistance ratios ⩽ 3%.

FOCUS POTENTIOMETER UNITS

- For hi-bi colour picture tubes*, focusing voltage approx. 7 kV
- In conjunction with diode-split line output transformers or triplers with or without 25 kV bleeder resistor

QUICK REFERENCE DATA

	2322 460 90027	2322 460 90028	2322 460 90029
Nominal resistance	24 MΩ ± 10%	83 MΩ ± 15%	83 MΩ ± 15%
Maximum dissipation at 70 °C	3,8 W	3,8 W	3,8 W
Climatic category, IEC 68	20/070/21	20/070/21	20/070/21

APPLICATION

These focus potentiometer units are for adjustment of the focusing voltage for hi-bi colour picture tubes.

DESCRIPTION

The potentiometer units comprise three resistance elements, which are connected in series. The centre element is provided with a slider (see also Figs 2, 4 and 6). The resistance elements are of the thick-film type; they are attached to a non-conductive temperature-resistant base (Al_2O_3, 96%).
Potentiometer unit 2322 460 90027 is designed for an input voltage of 8,3 kV; the units 2322 460 90028 and 2322 460 90029 are designed for applications with a 25 kV bleeder resistor.
To obtain better stability of the focusing voltage, unit 2322 460 90028 is, moreover, provided with a tap for connection to the 6,25 kVtap of a 4-diode-split line output transformer (e.g. AT2076/30); unit 2322 460 90029 has a similar tap for connection to the 8,3 kV tap of a tripler or a 3-diode-split line output transformer (e.g. AT2076/51).
The housing of the potentiometer units is of grey, self-extinguishing, glass-fibre-filled thermoplastic material.
The units are provided with snap-in clasps for mounting.

* Focus potentiometer units for low-bi colour picture tubes are supplied under catalogue numbers 2322 460 90016, 2322 460 90018 and 2322 460 90022; see the relevant data sheet.

OUTLINES

Dimensions in mm

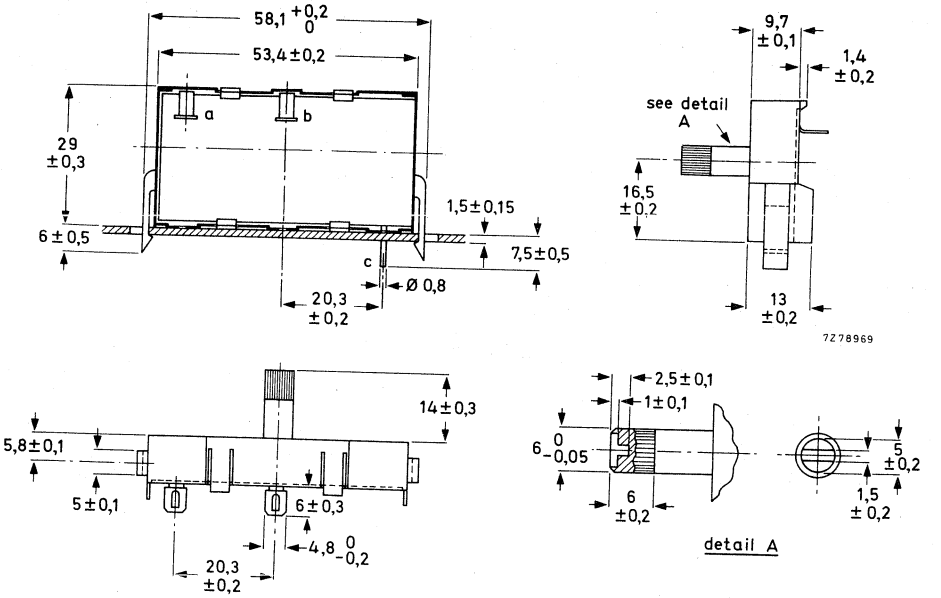


Fig. 1 Potentiometer unit **2322 460 90027**. The indication of the terminals corresponds to those shown in Fig. 2. The solder tags fit on Faston receptacles (4,8 x 0,5).

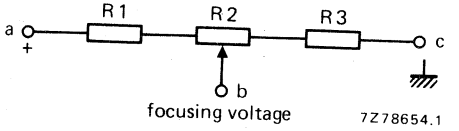


Fig. 2 Diagram of potentiometer unit **2322 460 90027**.

a = focus output voltage of e.h.t. device (8,3 kV);
b = focusing voltage;
c = earth.

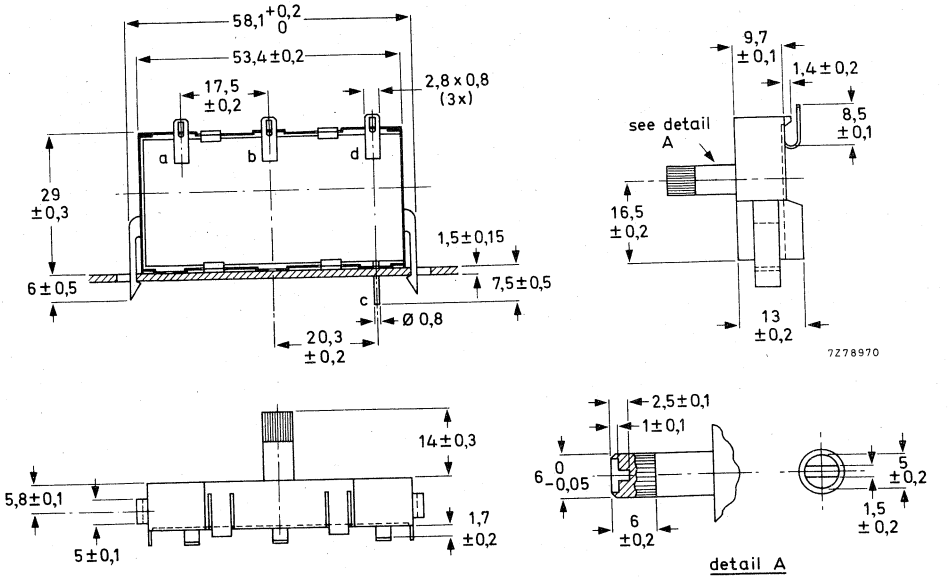


Fig. 3 Potentiometer unit **2322 460 90028.** The indication of the terminals corresponds to those shown in Fig. 4. The solder tags fit on Faston receptacles (2,8 x 0,8).

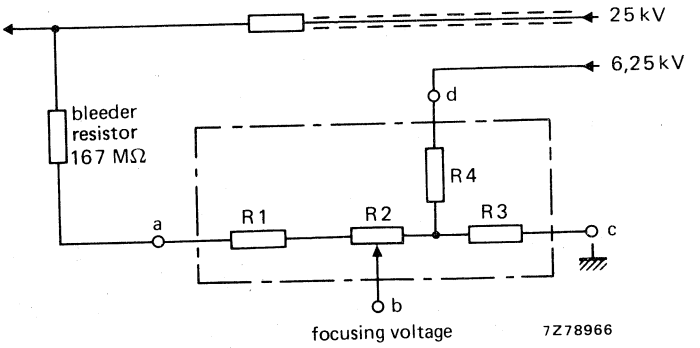


Fig. 4 Diagram of potentiometer unit **2322 460 90028.**
a = e.h.t. voltage via bleeder resistor;
b = focusing voltage;
c = earth;
d = 6,25 kV connection.

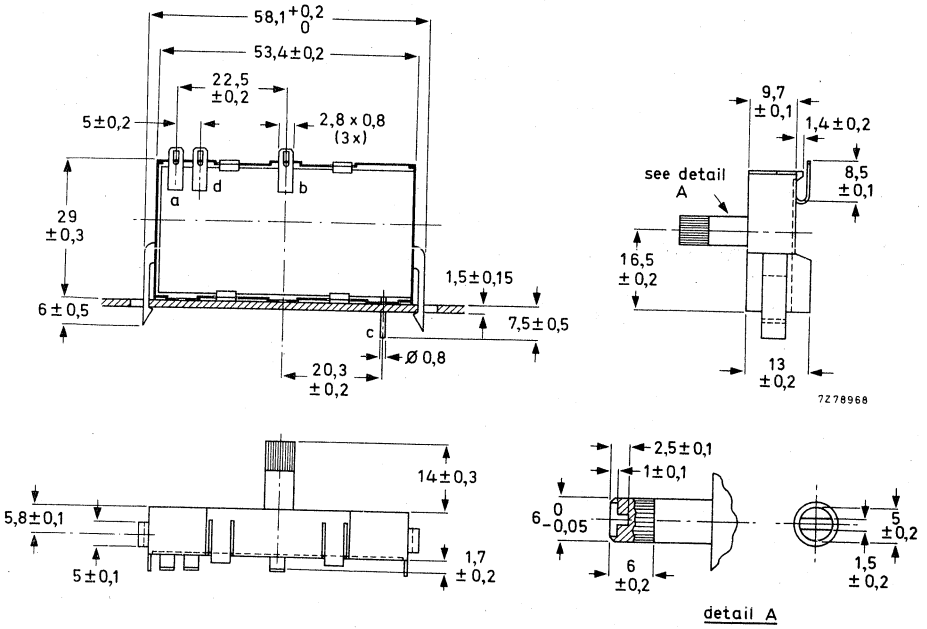


Fig. 5 Potentiometer unit **2322 460 90029.** The indication of the terminals corresponds to those shown in Fig. 6. The solder tags fit on Faston receptacles (2,8 x 0,8).

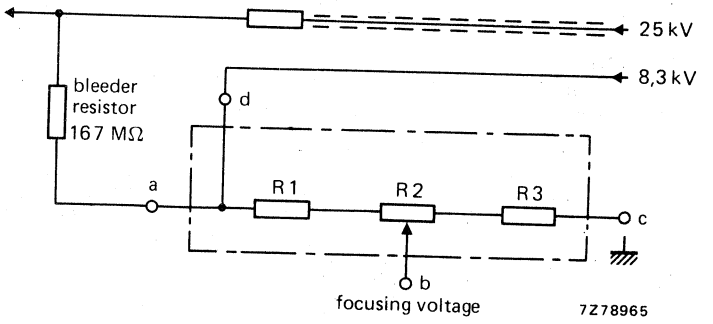


Fig. 6 Diagram of potentiometer unit **2322 460 90029.**

a = e.h.t. voltage via bleeder resistor;
b = focusing voltage;
c = earth;
d = 8,3 kV connection.

TECHNICAL DATA

	2322 460		
	90027	90028	90029
Nominal resistance value (R1 + R2 + R3, Figs 2, 4 and 6)	24 MΩ	83 MΩ	83 MΩ
Tolerance on nominal resistance	± 10% *	± 15%	± 15%
Resistance ratio at 25 °C (focusing voltage range)			
$\frac{R3 + R2}{R_{tot}}$	⩾ 0,94 (max. 0,98)	⩾ 0,94 (max. 0,98)	⩾ 0,94 (max. 0,98)
$\frac{R3}{R_{tot}}$	⩽ 0,75	⩽ 0,75	⩽ 0,75
Variation in resistance ratios at 70 °C	⩽ 3%	⩽ 3%	⩽ 3%
Resistance law of R2	linear	linear	linear
Contact resistance	⩽ 350 kΩ	⩽ 750 kΩ	⩽ 750 kΩ
Maximum dissipation at 70 °C	3,8 W	3,8 W	3,8 W
Limiting element voltage	9 kV	10 kV	10 kV
Insulation resistance between interconnected terminals and mounting base at 500 V (d.c.)	$> 10^3$ MΩ	$> 10^3$ MΩ	$> 10^3$ MΩ
Test voltage between interconnected terminals and mounting base for 1 min	10 kV	15 kV	15 kV
Operation temperature range	−20 to + 70 °C	−20 to + 70 °C	−20 to + 70 °C
Climatic category, IEC 68	20/070/21	20/070/21	20/070/21
Operating torque	3,5 to 30 mNm	3,5 to 30 mNm	3,5 to 30 mNm
Permissible end stop torque	⩽ 80 mNm	⩽ 80 mNm	⩽ 80 mNm
Permissible axial spindle load	⩽ 12 N	⩽ 12 N	⩽ 12 N

Note

Potentiometer units with different resistance values and resistance ratios, connecting terminals and spindles are available on request.

MOUNTING

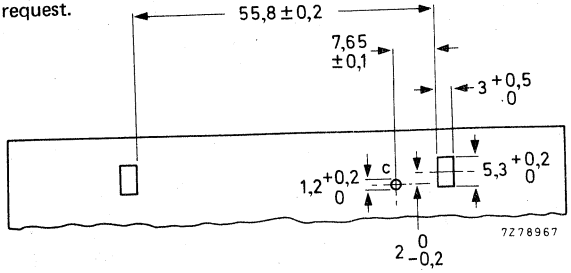


Fig. 7
Piercing diagram for board mounting (component side).

MARKING

The potentiometer units are marked with last five digits of the catalogue number, and period and year of manufacture.

* The ± 10% tolerance allows the possibility of applying a V_{g2} adjustment, with a total resistance of e.g. 3,8 MΩ, between terminal c and earth; as a result the resistance ratio $R3/R_{tot}$ becomes ⩽ 0,79.

TESTS AND REQUIREMENTS

IEC 68-2 test method	name of test	procedure (quick reference)	requirements
Ta	Soldering	Solder bath, non-activated colophony flux, solder temp. 235 °C, dwell time 2 s.	Good tinning.
Na	Rapid change of temperature	5 cycles of ½ h at −20 °C and ½ h at + 70 °C.	No damage; R_{tot} and resistance ratios shall be within tolerance limits.
	Vibration	50 Hz, 1 mm, 3 directions, 2 h per direction.	
	Dry heat	16 h at + 70 °C, no voltage applied. Reconditioning 2 h.	
	Cold	16 h at −20 °C; no voltage applied; 2 h reconditioning.	
	Rotational life	50 cycles at a rate of 10 cycles/min, no voltage applied.	
	Endurance	1000 h at 70 °C, 9 kV (d.c.) applied slider adjusted to 7 kV with respect to earth.	Stability of preset voltage ⩽ 0,5%.
	Humidity	21 days at 40 °C, R.H. 93%; 650 V (d.c.) applied	contact resistance and insulation resistance shall meet initial requirements.
	Resistance ratios	4 h at 70 °C, 9 kV (d.c.) applied; slider adjusted to 7 kV with respect to earth at 25 °C.	variation of resistance ratios ⩽ 3%.

TEST & BAND SWITCHES AND MANUAL PULSE GENERATOR

D

TEST SWITCHES

APPLICATION

These switches are designed to simplify the testing of any electronic circuit by providing a swift means of changing over from "normal working" to "test" conditions. They are often used for testing a particular section of a circuit immediately after set assembly or later during service.

DESCRIPTION

Three types of switch are available designed for mounting on printed-wiring boards. All types can be supplied for horizontal or vertical mounting.

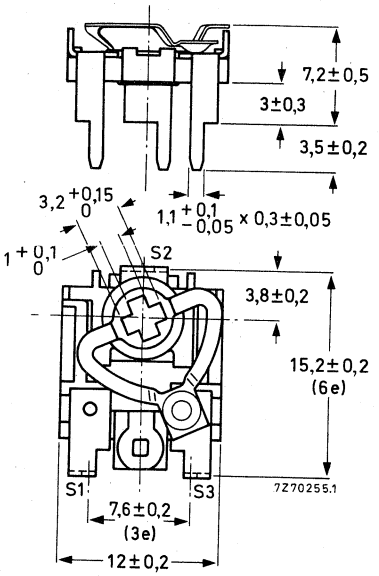
The basic switch consists of a rotatable selector contact and two or three switch connections, mounted on an insulating plate. By turning the selector contact one of the switch connections can be connected to the centre contact. The contacts are of the "break before make" type.

One switch type is provided with two active switch connections and a "centre-off" position. The second type has three active switch connections; the third type has two active switch connections (without "centre-off" position).

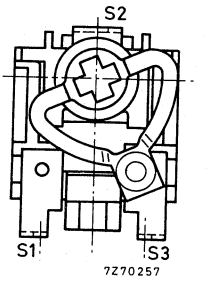
Switches are available for screwdriver-control (allowing the "flatness" of printed-wiring circuitry to be maintained), or finger-control by means of a plastic knob.

OUTLINES

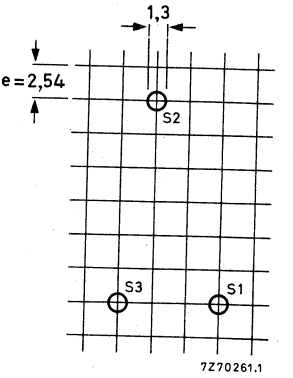
Dimensions in mm



a.



b.



c.

Fig. 1 Test switch for horizontal mounting, with two active switch connections:
a. with "centre-off" position,
b. without "centre-off" position,
c. hole pattern for mounting on a printed-wiring board (solder side).

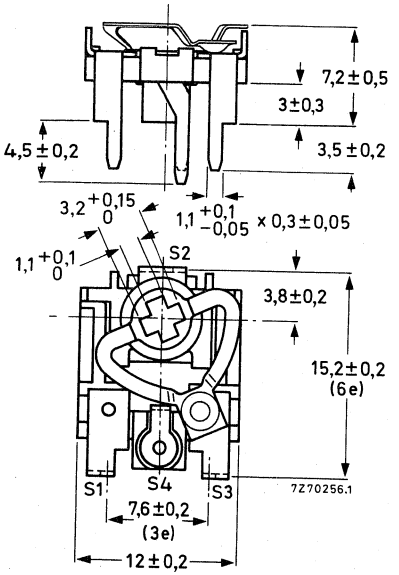


Fig. 2a Test switch for horizontal mounting, with three active switch connections.

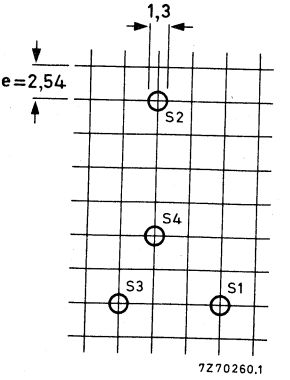


Fig. 2b Hole pattern for mounting on a printed-wiring board (solder side).

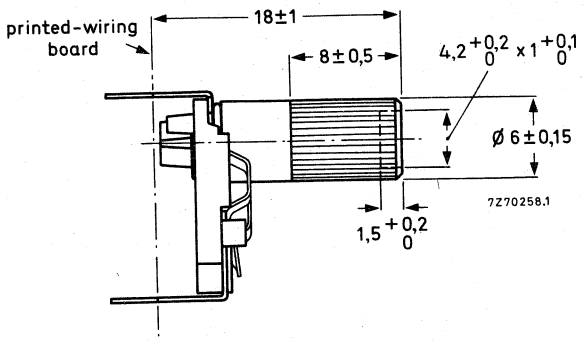


Fig. 3 Test switch for horizontal mounting with adjustment knob at the side of the selector contact.

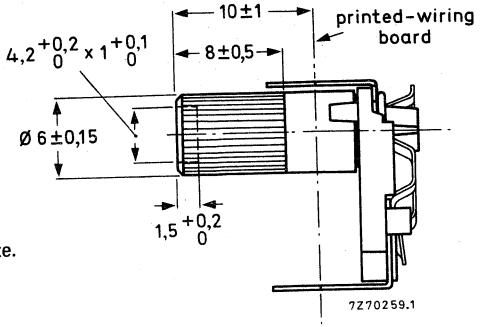
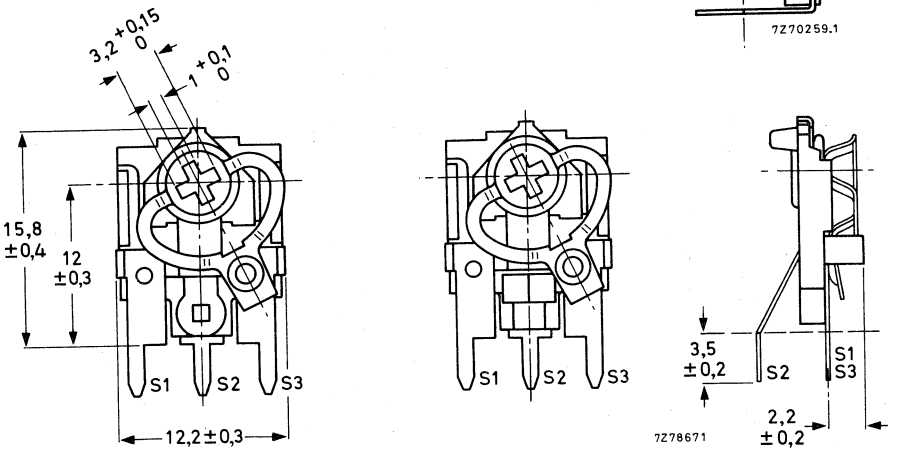
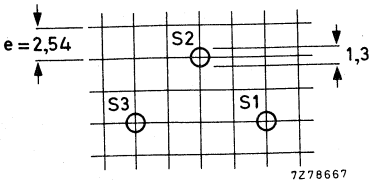


Fig. 4 Test switch for horizontal mounting with adjustment knob at the side of the base plate.



a. b.



c.

Fig. 5 Test switch for vertical mounting, with two active switch connections;
a. with "centre-off" position,
b. without "centre-off" position,
c. hole pattern for mounting on a printed-wiring board (solder side).

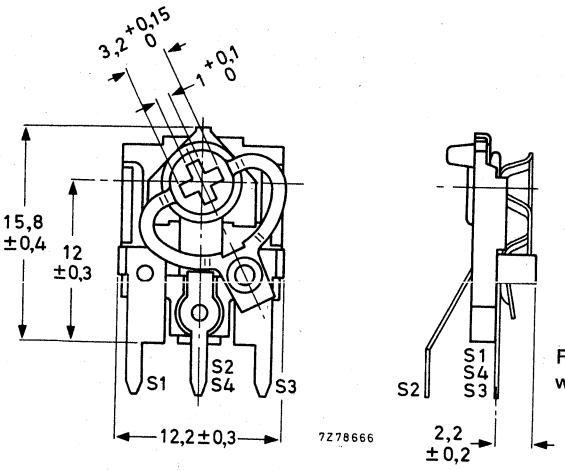


Fig. 6a Test switch for vertical mounting, with three active switch conditions.

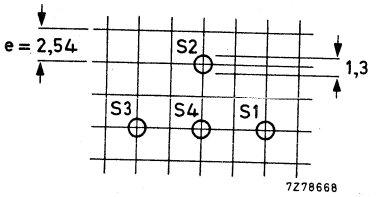


Fig. 6b Hole pattern for mounting on a printed-wiring board (solder side).

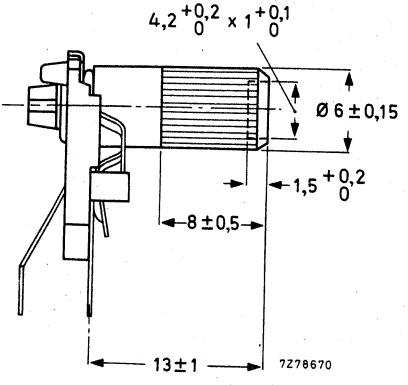


Fig. 7 Test switch for vertical mounting with adjustment knob at the side of the selector contact.

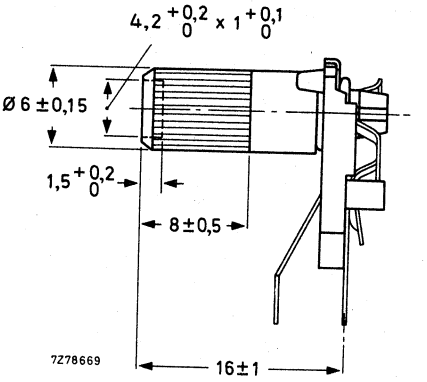


Fig. 8 Test switch for vertical mounting, with adjustment knob at the side of the base plate.

TECHNICAL DATA

Contact resistance	
initially	⩽ 20 mΩ
after 50 switching operations at ⩽ 10 mA, ⩽ 500 V	⩽ 200 mΩ
Operating torque	5 to 50 mNm
End stop torque	⩽ 100 mNm
Life	⩾ 50 switching operations
Mass	
switch without knob	approx. 1 g
switch with knob	approx. 1,5 g

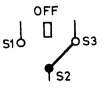
COMPOSITION OF THE CATALOGUE NUMBER

2422 136 7 ....

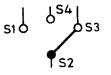
0 = without knob
1 = with knob at the side of the base plate
2 = with knob at the side of the selector contact

33 = horizontal mounting
72 = vertical mounting

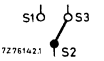
2 = with 2 active switch connections; with off position



3 = with 3 active switch connections



4 = with 2 active switch connections; without off position



BANDSWITCH

The switch is designed for band switching in television or radio tuners. It has three positions of the "break before make" type, and is operated by a lever. It is meant to be used with multiturn carbon preset potentiometers CMP10, CMP20, CMP40.

MECHANICAL DATA

Outline drawing

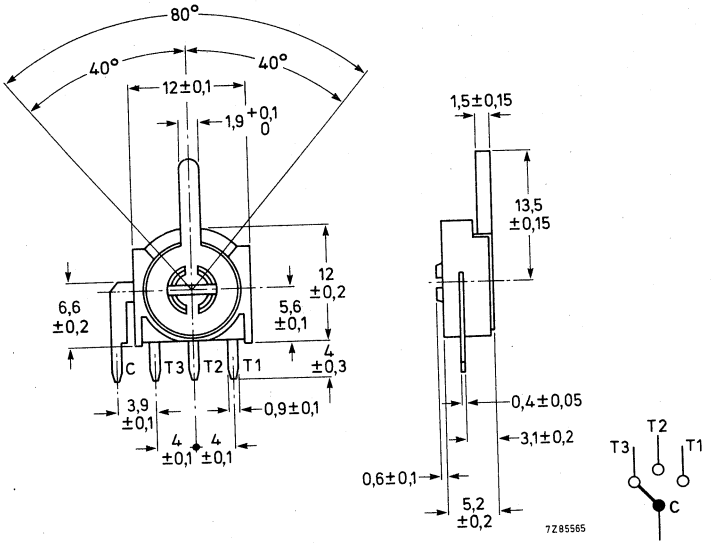


Fig. 1.

Operating torque	10 to 40 mNm
End stop torque	> 250 mNm
Switching angle	2 x 40 degrees
Climatic category	25/070/21
Life	> 1000 cycles
No marking on the switch	

ELECTRICAL DATA

Rating (load applied)	35 V/20 mA
Function	1 section, 3 contacts
Contact resistance, max.	50 mΩ at 5 mA
Catalogue number	2422 136 80223

MANUAL PULSE GENERATOR

APPLICATION

A manually operated pulse generator which produces two quadrature pulse trains for feeding angular rotation and direction of rotation information to digitally controlled equipment, e.g. microcomputer-controlled radio tuning systems.

DESCRIPTION

The pulse generator employs LEDs and phototransistors to generate two pulse trains which can be amplified in a separate unit. An integrated Schmitt-trigger squares the output signals. The unit is mounted in the same manner as a potentiometer. The operating friction prevents flywheel action. The construction is non-sealed. The housing is of black polycarbonate, the spindle is aluminium. The pulse generator can be connected by a modular 0,1 inch pitch connector, such as F095, or can be soldered.

MECHANICAL DATA

Dimensions in mm

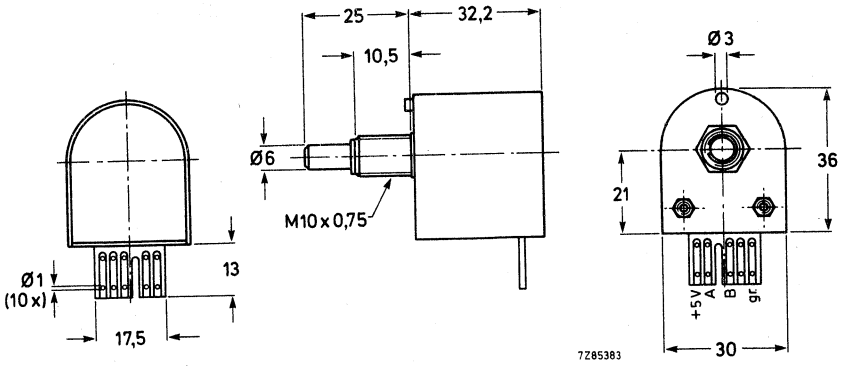


Fig. 1.

CATALOGUE NUMBER

2422 549 90001

RATINGS AND CHARACTERISTICS

Input voltage (d.c.)	max. 5 V
Input current	$\leqslant$ 40 mA
Resolution	256 pulses per rev. 128 pulses output A 128 pulses output B
Phase shift between outputs A and B	see Fig. 2
Reproducibility	± 10' of arc.
Output	see Fig. 2
Electrical circuit	see Fig. 3
Output load 10 kΩ (I_b max. = 0,5 mA)	logic "1" 4,0 V min. logic "0" 0,5 V max. square wave
Operating torque	8 - 30 mNm
Maximum allowable axial force (push and pull)	$\leqslant$ 100 N
Life	1.10^6 revolutions
Operating temperature	−25 °C to + 60 °C
Storage temperature	−40 °C to + 75 °C
Damp heat steady state (21 days) IEC 68-2-3(c)	
Bump IEC 68-2-29(Eb) 40g - 6 ms - 4000 bumps	no displacement
Vibration IEC 68-2-6(Fc) 10 - 150 Hz; 5g, 6 h	no displacement

Logic

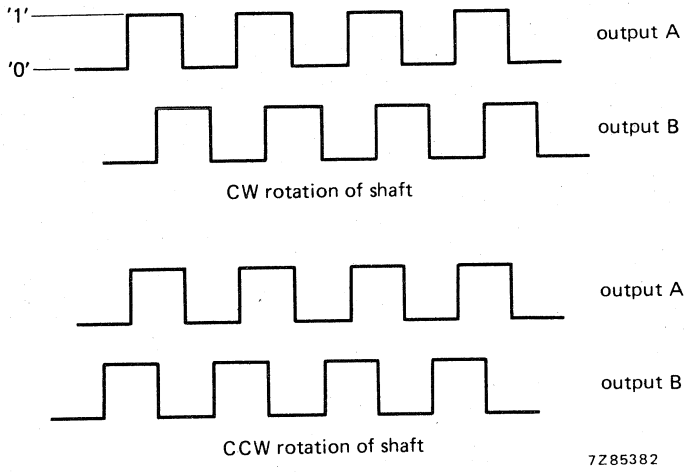


Fig. 2 Output pulses.

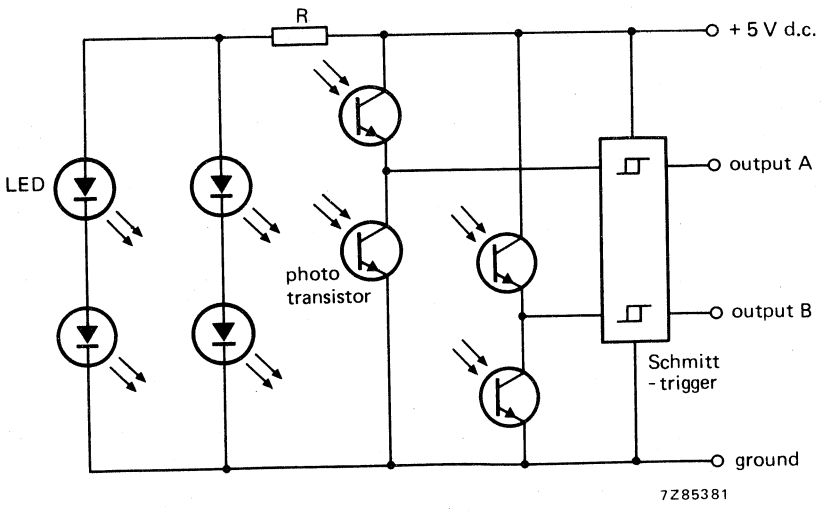


Fig. 3 Electrical circuit.

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